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Abundance and Distribution of Migratory Bull Trout in the Upper Oldman River Drainage, 2007 – 2010

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Abundance and Distribution of Migratory Bull Trout in the Upper Oldman River Drainage, 2007 – 2010

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Conservation Report Series Type
Technical

ISBN printed: 978-0-7785-9465-9
ISBN online: 978-0-7785-9466-6
Publication No.: T/248

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Suggested Citation:

Hurkett, B., J. Blackburn, and T. Council. 2011. Abundance and distribution of migratory bull trout in the upper Oldman River drainage, 2007 - 2010. Technical Report, T-2011-002, produced by the Alberta Conservation Association, Lethbridge, Alberta, Canada. 34 pp + App.

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EXECUTIVE SUMMARY

Throughout the last century, Alberta's bull trout (*Salvelinus confluentus*) populations have been in decline. This decline is attributed to impacts associated with human activities including angling pressure, habitat fragmentation and degradation, the creation of migratory barriers and the introduction of non-native fish stocks. As a result, the distribution of Alberta's bull trout is now restricted to headwater drainages along the East Slopes of the Rocky Mountains. In particular, the distribution of bull trout in the Oldman River watershed has been reduced to 33% of its historic range, with the majority of the populations occupying headwater drainages, including the upper Oldman (UOM) River drainage. Industrial and recreational activities, such as logging and off-highway vehicle use, are currently intensifying in the UOM River drainage and the cumulative effects of these activities have led to the degradation of bull trout habitat. The current status of bull trout in the UOM River drainage remains unclear since few studies have been completed on this population, which therefore complicates the management of the fishery.

Alberta Conservation Association conducted a four-year bull trout population assessment in the UOM River drainage. The study's objectives were to determine the abundance of migratory adult bull trout, identify the migratory patterns of bull trout, and identify bull trout spawning habitat throughout the drainage. We installed fish traps in four historic bull trout spawning tributaries, Hidden Creek, the lower Livingstone River, Racehorse Creek and Dutch Creek, to capture post-spawn migratory bull trout. We marked each captured adult bull trout (≥300 mm FL) with a transponder tag which permitted us to identify recaptured fish during trapping.

Recapture data allowed us to observe the migratory patterns of bull trout throughout the UOM River drainage. We recaptured several bull trout originating from Hidden Creek in the lower Livingstone River, Racehorse Creek, Dutch Creek, and the lower Oldman River. We also recaptured bull trout originating from Dutch and Racehorse creeks in the lower Livingstone River.

We conducted redd surveys to identify bull trout spawning habitat throughout the UOM River drainage. Since 2008, we have confirmed spawning areas in all historic bull trout spawning tributaries, namely Hidden Creek, the lower Livingstone River, Racehorse Creek, and Dutch Creek. We confirmed additional spawning habitat in the UOM River, the upper Livingstone River, South Racehorse Creek, Savanna Creek, and Daisy Creek. We observed the largest number of bull trout redds in Hidden Creek and fish to redd ratios suggest that they were produced by migratory fish. Bull trout redds observed upstream of Livingstone River Falls, specifically the upper Livingstone River, and Savanna Creek, were classified as stream-resident redds since migratory fish cannot pass this barrier. In Dutch Creek and Racehorse Creek we observed a greater number of redds than fish captured by our fish traps, indicating that both stream-resident and migratory bull trout spawn in these tributaries.

Over three-quarters of our total fish trap catch was from Hidden Creek, indicating that this is a vital migratory bull trout spawning tributary. The remaining migratory fish were captured in Dutch Creek, Racehorse Creek, and the lower Livingstone River, suggesting that these spawning tributaries contribute fewer migratory fish to the UOM River drainage bull trout population. However, post-spawn fish movements attest to the interconnectedness of the UOM bull trout population and their dependence on all tributaries in the drainage. It is apparent that each bull trout spawning tributary in the UOM River drainage plays a key role in the long-term persistence of the UOM bull trout population and if degradation of these streams continue, bull trout populations may be at further risk.

Key words: Alberta, abundance, bull trout, distribution, migratory, stream-resident, upper Oldman River drainage

ACKNOWLEDGEMENTS

Funding for this study was provided by the Alberta Conservation Association (ACA) and Devon Canada Corporation. Many thanks to the ACA fisheries crews who contributed their time and effort to make this study successful: Andrew Clough, Brad Downey, Brad Taylor, Chris Delage, Clint Goodman, Jason Leatham, Layne Seward, Mike Jokinen, Mike Marquardson, Mike Uchikura, Mike Verhage, and Tyler Johns. We extend our gratitude to all volunteers who assisted with field work.

Thank you to Daryl Wigg and Matthew Coombs with Alberta Sustainable Resource Development (ASRD), for assistance with field work and the provision of additional field equipment. Thanks to Ken Tom Thompson, Forestry Camp Manager with ASRD, for the hospitality at Livingstone Gap Fire Base. Thank you to Mike Gerrand (Cows and Fish) for training ACA fisheries staff to conduct redd surveys.

Thanks to Kevin Fitzsimmons, and Mike Rodtka (ACA) for their constructive statistical input. An additional show of gratitude to Mandy Couve, Mike Rodtka, and Peter Aku (ACA) and Glenda Samuelson for report edits.

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1.0 INTRODUCTION

Throughout the last century, the abundance and distribution of Alberta's bull trout (*Salvelinus confluentus*) populations have drastically declined and the species is currently restricted to the headwater drainages of the Peace, Athabasca, North Saskatchewan, and South Saskatchewan river basins. This decline is attributed to anthropogenic impacts, including angling pressure, habitat fragmentation and degradation, the creation of migratory barriers, and the introduction of non-native fish stocks (ASRD and ACA 2009). The decline in bull trout populations has resulted in threatened designations and extirpation throughout the species' native range (Rieman and Clayton 1997; Nelson et al. 2002). Currently, the General Status of Wild Species (2000) has ranked Alberta's bull trout as a "Sensitive" species and the United States Endangered Species Act (1999) has listed bull trout (lower 48 states) as a "Threatened" species.

Bull trout inhabit unproductive coldwater streams, rivers, and lakes, which contribute to the species' slow growth rate, late maturity and non-repetitive spawning behaviour (Nelson and Paetz 1992). Bull trout prefer diverse habitats with stable surface and subsurface flows, low proportions of fine sediments, available cover, cold water, and open migratory corridors (McCart 1997; Watson and Hillman 1997; Haas 2001). The expression of different life history strategies in a bull trout population is attributed to habitat diversity and connectivity (Rieman and Clayton 1997). The specific habitat preferences and low reproduction and growth rates of bull trout contribute to their sensitivity to environmental, biological, and anthropogenic disturbances (Nelson and Paetz 1992; ASRD and ACA 2009).

Bull trout exhibit two main life history strategies; non-migratory and migratory. In Alberta, non-migratory bull trout permanently reside in low-order headwater streams, whereas migratory bull trout reside in large rivers or lakes and migrate to spawn in headwater streams. Non-migratory bull trout are also referred to as stream-residents, as spawning and rearing occurs within their natal stream (Nelson and Paetz 1992). These fish mature earlier and are typically smaller than migratory fish (<300 mm fork length - FL) because they reside in low-productivity waterbodies (Bellerud et al. 1997; Earle and McKenzie 2001). Stream-resident bull trout populations are generally isolated from other bull trout populations, typically by migration barriers (McPhail and Baxter 1996).

There are two types of migratory life history forms; fluvial bull trout which inhabit larger main-stem streams and rivers most of their life, and adfluvial bull trout which reside in lakes and reservoirs (McPhail and Baxter 1996). Migratory bull trout grow larger than stream-resident fish (≥300 mm FL) because they reside in larger, more productive waterbodies (Clayton 1999; Hvenegaard and Thera 2001). Migration can be extensive; bull trout have been documented to migrate up to 400 km (McPhail and Baxter 1996). Upstream migration occurs early in the summer as water temperatures and stream flows increase, and timing typically varies depending on the distance migrated (Mushens 2003; Popowich and Paul 2006; Monnot et al 2008).

Life history strategies and fish density are two factors that affect bull trout spawning behaviour (ASRD and ACA 2009). Alternate-year spawning, where individuals spawn once every two years, is common among migratory bull trout populations (Nelson and Paetz 1992). Non-repetitive spawning is also common in migratory fish because of the high energy costs associated with migration and gamete development (ASRD and ACA 2009). Repetitive spawning occurs less in Alberta's migratory bull trout populations as less than 20% of migrants return annually to spawn (Hvenegaard and Fairless 1998; Johnston and Post 2009). As adult fish densities increase, non-repetitive spawning becomes more common, especially amongst females (Johnston and Post 2009).

As an apex predator, the migratory life cycle of bull trout is a highly successful strategy (Whitesel et al. 2004). It is common for stream-resident and migratory bull trout to inhabit the same waterbody, but where these two life history forms coexist, the migratory form is dominant (Fredenberg et al. 2005). Historically, the upper Oldman (UOM) River bull trout population exhibited both, stream-resident and fluvial, life history forms, but since the development of the Oldman River Dam, an adfluvial bull trout population is believed to have become established in the Oldman Reservoir (Warnock 2008).

The UOM River drainage supports two main bull trout populations, the Livingstone River population and the Oldman River population. Within these two populations, there are four subpopulations, Hidden Creek, Racehorse Creek, the lower Livingstone River, and the upper Livingstone River (Warnock 2008). The upper Livingstone River sub-population consists primarily of stream-residents. This population contributes a small number of migrants to downstream populations due to the impassable fish barrier created by the Livingstone River Falls (Warnock 2008). The remaining three sub-populations are migratory, with Hidden Creek comprising the largest population, Racehorse Creek the second largest, and the lower Livingstone River the smallest. Bull trout also inhabit Dutch Creek and originate from the Hidden Creek sub-population (Warnock 2008). These sub-populations are believed to be short-range migrants, migrating less than 50 km, likely because of seasonal barriers within the UOM River drainage (Warnock 2008).

Bull trout distribution within the Oldman River watershed has decreased to 33% of its historic distribution, largely since the 1950s (Fitch 1997). The cumulative effects of logging, gas exploration and extraction, off-highway vehicle use, livestock grazing, and random access camping have negatively impacted bull trout and their habitats in the UOM River drainage. Recently these industrial and recreational activities have intensified, particularly in sub-drainages that support bull trout spawning. Few bull trout studies have been completed in the UOM River drainage, so the current status of the UOM bull trout population remains unclear. Baseline data on migratory bull trout abundance and distribution with the UOM River drainage are necessary before long-term industrial and recreational activities further affect the population.

Alberta Conservation Association (ACA) completed a four-year study documenting the abundance of migratory bull trout sub-populations, the distribution of bull trout spawning habitat, and the migratory patterns of bull trout throughout the UOM River drainage. Our study focused on capturing and marking migratory bull trout in historic spawning tributaries and conducting redd surveys in historic bull trout spawning tributaries throughout the UOM River drainage. This document is the final report documenting the data collected between 2007 and 2010. The main objectives of our study were to:

1. Determine the abundance of migratory adult bull trout in the Hidden Creek, lower Livingstone River, Racehorse Creek, and Dutch Creek sub-populations.

2. Identify migration patterns of bull trout throughout the UOM River drainage.

3. Identify spawning reaches in historic and suspected bull trout spawning tributaries throughout the UOM River drainage.

2.0 STUDY AREA

The UOM River drainage originates in southern Alberta along the East Slopes of the Rocky Mountains (Figure 1). The entire headwater drainage is confined between the Continental Divide and the Livingstone Range, and is comprised of coldwater streams and rivers. Major tributaries entering the UOM River include the Livingstone River, Hidden Creek, Dutch Creek, Racehorse Creek, Vicary Creek and Daisy Creek.

Numerous, permanent and seasonal, fish barriers exist in the UOM River drainage. At the lower reach of the drainage, the UOM River flows through the Gap Canyon which contain a series of 3 to 4 m waterfalls that constitute the Gap Falls. Downstream of Gap Falls, the Oldman River flows approximately 50 km through the foothills before it enters the Oldman Reservoir. Just upstream of the Oldman Reservoir, the Oldman River flows through a second canyon known as Waldrons Flats, consisting of Waldrons Falls, a 3 to 4 m ledge that produces a large plunge pool. Other falls include the Livingstone River falls, and Vicary Creek falls all of which constitute permanent fish barriers that prohibit upstream fish passage. No fish species are present upstream of Vicary Creek falls and Westslope cutthroat trout (*Oncorhyncus clarkii lewisii*) are the only species present upstream of the UOM River falls.

The UOM River drainage is popular among local, national, and international anglers. Trout harvest is permitted in the UOM River with the exception of the province-wide zero harvest regulation for bull trout (ASRD 2010). A catch-and-release regulation is in effect for all fish species throughout the Livingstone River drainage and the UOM River downstream of the Racehorse Creek confluence.

Our study area encompasses the entire UOM River drainage, including all major tributaries, upstream of the Gap Falls.

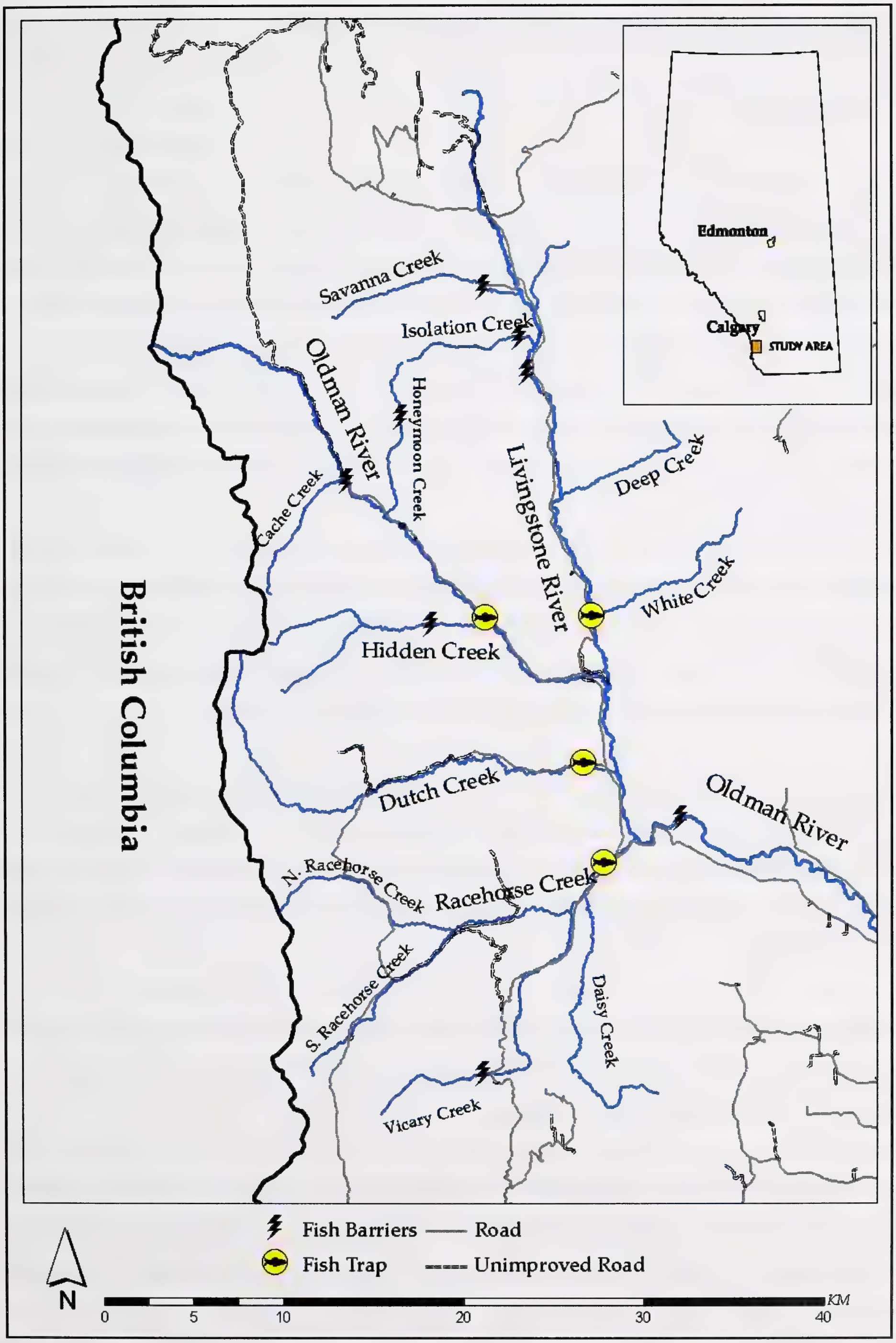

Figure 1. Upper Oldman River drainage bull trout fish trap locations, 2007 - 2010.

3.0 MATERIALS AND METHODS

3.1 Fish traps

In 2007 we installed a bi-directional aluminium conduit fish trap in Hidden Creek to capture migratory adult bull trout (≥300 mm FL) to determine the importance of the creek as a spawning tributary and to identify the timing of the post-spawn run (Appendix 1). The trap consisted of two holding cages installed directly adjacent to one another, in order to capture both pre-spawn and post-spawn migratory bull trout. The trap was installed during the last week of July and removed in the fall, when no fish had been captured for a period of five consecutive days. Results from this preliminary year of trapping allowed us to develop a trapping protocol which targeted the post-spawn migration.

From 2008 to 2010 we installed four uni-directional fish traps in the fall to capture post-spawn migratory adult bull trout in Hidden Creek, the Livingstone River, Racehorse Creek, and Dutch Creek. Fish traps were installed in the second last week of August until a period of five consecutive days in which no fish were captured.

Each fish trap consisted of aluminium conduit held in place with aluminium frames and steel A-frame support stands. We positioned holding cages in the middle of run sections and attached trap wings at approximately a 45 degree angle from the cage to the adjacent stream banks to produce a V-shaped fish barrier that funnelled migrating fish into the holding cage.

To assess the relationship between water temperature and the timing of post-spawn migration, we installed HOBO (Onset) temperature data loggers in each spawning tributary while the fish trap was operational.

Traps were checked daily to reduce fish stress and minimize mortality. Before checking a trap, we captured fish staging upstream and downstream of the trap using dip nets. We individually marked all bull trout ≥300 mm FL with Passive Integrated Transponders (PIT). We scanned all adult bull trout with a Biomark pocket reader to identify recaptured fish. PIT tags were injected into the dorsal musculature at the base of the dorsal fin using a sterilized 12-gauge needle. Prior to insertion, we scanned and recorded the marker tag and following tag insertion we applied a second scan to ensure tag retention. We anaesthetized newly captured fish in a clove oil solution (10 drops clove oil/10 mL of anhydrous ethanol/10 L water) to reduce stress and ease fish handling prior to tag insertion.

We measured fork length (mm), total length (mm) and weight (g) for each captured fish. We determined fish sex either by gently stripping the fish abdomen and observing the extruded reproductive material (milt or eggs) or by identifying males by the presence of a kype and an orange coloured abdomen (Baxter 1997); sex was noted as "undetermined" for all other fish. Following sampling, we allowed fish to revive and released them back into the stream, away from the trap in accordance with their original direction of travel.

In 2010, unseasonably high precipitation resulted in high stream flows and caused fish trap failures in the lower Livingstone River, Racehorse Creek, and Dutch Creek locations on 20 September. We successfully reinstalled the Dutch Creek fish trap on 23 September, 2010 but were unable to reinstall those in Livingstone River and Racehorse Creek.

3.2 Redd surveys

Beginning in 2008, redd surveys were conducted in all historic and suspected bull trout spawning tributaries in the UOM River drainage. A minimum of three surveys were conducted in all known spawning reaches of the historic spawning streams. These surveys were staggered throughout the spawning season to monitor the progress and timing of spawning. Final redd surveys were completed in the last week of trapping to ensure spawning was complete, to account for fish that remained upstream of the traps, and to count the total number of bull trout redds in the stream. We conducted additional redd surveys in suspected spawning streams including the Oldman River, Savanna Creek, Isolation Creek, Mean Creek, and Daisy Creek. We surveyed each of these streams at least once and completed three surveys on streams where redds were observed in the initial survey.

Our redd survey methodology followed established protocols (Gerrand and MacCulloch 1995; Gerrand and Watmough 1996) and consisted of two or more crew members wading upstream and observing bull trout redds and/or spawning activity. At each redd we recorded redd length (cm), redd width (cm) and water depth (cm) (Appendix 2); for superimposed redds, we enumerated the total number of pits and measured a representative water depth for the entire spawning area. GPS locations were acquired for each redd using a Garmin GPSMap 60Cx GPS unit (UTM, NAD 83, Zone 11).

3.3 Sample angling

We angled to capture and tag adult bull trout in an effort to identify migratory fish entering the study area. Angling was conducted between April and July, 2007 to 2009, the time when bull trout commenced their upstream migration. Our angling efforts were focused on the plunge pools of Gap Falls and Waldron Falls, where we observed bull trout staging prior to migration. We sampled and tagged all adult bull trout (≥300 mm FL) with the same methods as at our fish traps.

3.4 Electrofishing

In 2007, we electrofished 46 sites throughout the UOM River drainage as part of our population abundance and stock assessment of Westslope cutthroat trout study (see Blackburn 2008). At the same time we sampled and tagged all adult bull trout (≥300 mm FL) with the same methods used at our fish traps.

4.0 RESULTS

4.1 Hidden Creek

4.1.1 Fish trap catch

We captured 229 migratory adult bull trout in Hidden Creek between 2007 and 2010, which represents 79% (n=291) of the total trap catch for the UOM River drainage (Appendix 3). In 2007, we captured 123 bull trout which represented the largest yearly catch during the study (Table 1). In 2008 and 2009 the Hidden Creek bull trout sub-population represented, 73% and 81%, respectively of the total catch in the UOM River drainage (Figure 2). Thus, based on numbers, it is evident that the Hidden Creek sub-population represents the majority of the UOM migratory adult bull trout population.

Table 1. Mark-recapture history of bull trout in Hidden Creek, 2007 – 2010.

Trapping year	Number captured	Number newly marked	Number recaptured in subsequent years		
			2008	2009	2010
2007	123	121	28	23	22
2008	81	53	--	9	17
2009	60	27		--	6
2010	73	28			--
Total	337	251	28	32	45

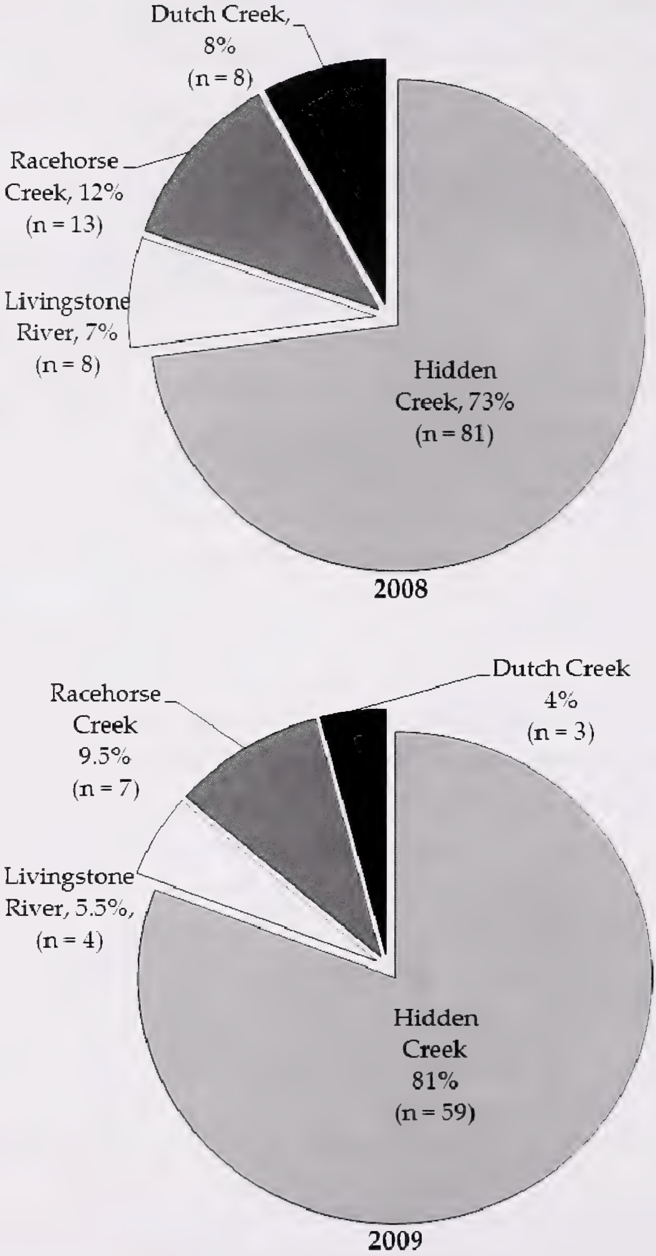

Figure 2. Proportion of migratory adult bull trout captured in fish traps in the upper Oldman River drainage, 2008 and 2009.

4.1.2 Spawning behavior

Both repetitive and non-repetitive spawning behaviour was observed in Hidden Creek, but non-repetitive was the most common. Of the 229 bull trout captured, 65% (n=149) were encountered once, 14% (n=33) were alternate-year spawners caught every second year, and 21% (n=47) were consecutive-year spawners caught in two or more successive years. Of the 47 alternate spawners, 20 were males, 24 were females, and 3 were undetermined. Site fidelity was common amongst the Hidden Creek bull trout population as 35 to 65% of the total trap catches between 2008 and 2010 were recaptured bull trout from previous years.

Each year, the post-spawn migration began during the first week of September and remained steady until the third week of September (Appendix 4). Catch rates generally peaked during the second week of September and with the exception of a few individuals, the post-spawn run was complete before October. Typically, the post-spawn run began when stream average water temperature dropped below 8°C.

4.1.3 Migratory patterns

Over the duration of the study we observed several post-spawn bull trout from Hidden Creek migrate to other major tributaries throughout the UOM River drainage. In 2007, one Hidden Creek bull trout was recaptured at an electrofishing site in the Livingstone River, immediately upstream of the confluence of the Livingstone and Oldman rivers. In 2008, 11 post-spawn Hidden Creek bull trout were recaptures; 7 in the Livingstone River, 2 in Dutch Creek, and 2 in Racehorse Creek. One Hidden Creek bull trout tagged in 2007 was recaptured by angling in the plunge pool downstream of the Gap Falls in May 2008 and was recaptured a second time in Hidden Creek in September 2008.

In 2009, fewer Hidden Creek bull trout were recaptured at other major tributaries throughout the drainage than in 2008. In total, 4 Hidden Creek bull trout tagged in 2008 were recaptured; 2 in the lower Livingstone River, one of which was also recaptured in 2008; 1 in Racehorse Creek; and 1 in Dutch Creek. The fish recaptured in Dutch Creek was recaptured a second time in Hidden Creek in 2010. During 2010, 2 fish tagged in Hidden Creek in 2008, were recaptured a second time in Hidden Creek and recaptured a third time in the lower Livingstone River. Two additional Hidden Creek bull trout tagged in 2007 and 1 tagged in 2008 were recaptured in the lower Livingstone River in 2010. We recaptured 2 Racehorse Creek bull trout in Hidden Creek in 2010.

4.1.4 Redd survey

Beginning in 2008, we completed redd surveys throughout the entire survey reach in Hidden Creek (10.6 km). In all three survey years, we observed that most redds were situated downstream of the Hidden Creek Falls (Figure 3). In 2008, we observed 11 redds upstream of the falls but did not locate any additional redds in this region in subsequent years. In 2008, 108 redds were observed throughout the entire reach of Hidden Creek, 97 of which were downstream of the falls. All redds in 2009 (n=77) and 2010 (n=39) were located downstream of the falls. Unseasonably high flows prevented redd surveys during the latter part of the 2010 spawning season.

The highest density of bull trout redds occurred in a 100 m reach of the stream, approximately 200 m downstream of the falls. Spawning activity, (ie. fish were observed to be on or near redds) peaked between the last week of August and mid-September after which time fewer new redds were observed. In both 2008 and 2009, the number of bull trout redds were higher than the number of fish captured in traps and fish to redd ratios were similar for both years at 0.76 (82 bull trout: 108 redds) for 2008 and 0.77 (59 bull trout: 77 redds) for 2009.

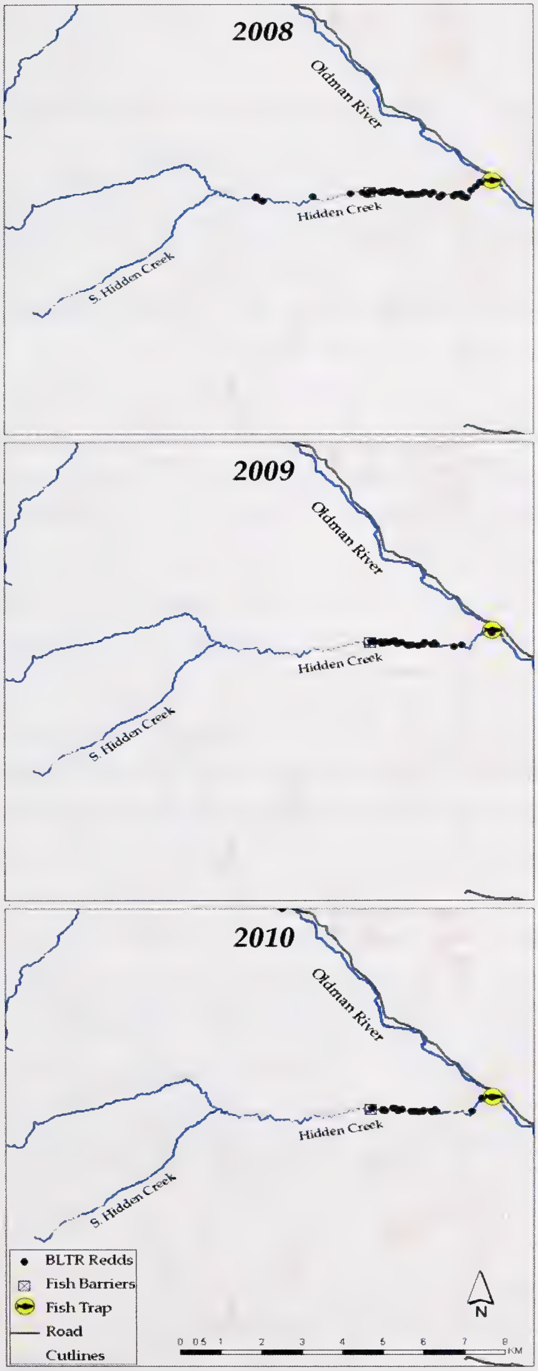

Figure 3. Distribution of bull trout (BLTR) redds observed in Hidden Creek, 2008 - 2010.

4.1.5 Size structure

Overall, the length of bull trout captured in Hidden Creek during our study ranged from 308 to 800 mm FL, with an associated weight range of 125 to 5,500 g (Table 2; Appendix 5); the largest fish (800 mm FL, 5,550 g) was a male captured in 2010. Yearly mean length and weight ranges were 552–561 mm FL and 1,662.4-1,852.6 g, respectively.

Table 2. Summary of measurements of bull trout captured in Hidden Creek, 2007 – 2010.

Year	Fork length (mm)		Weight (g)		n
	Mean (±SD)	Range	Mean (±SD)	Range	
2007	551.8 ± 95.8	308 - 760	1,762.5 ± 852.3	125 – 4,000	123
2008	560.5 ± 92.8	321 - 751	1,852.6 ± 852.6	328 – 3,950	81
2009	547.6 ± 91.0	373 - 778	1,662.4 ± 840.3	400 – 4,500	60
2010	551.9 ± 90.4	399 - 800	1,762.7 ± 938.8	650 – 5,500	73

Where sex was identified, males were more abundant than females in all years (Table 3). However, a true representation of sex ratio was not possible because of the high number of individuals with undetermined sex.

Table 3. Sex distribution of bull trout captured in Hidden Creek, 2007 - 2010.

Sex	2007	2008	2009	2010
Male	51	41	26	35
Female	42	28	20	22
Undetermined	30	12	13	16
Total	123	81	59	73

4.2 Livingstone River

4.2.1 Fish trap catch

A total of 31 migratory adult bull trout were captured in the lower Livingstone River fish trap between 2008 and 2010. The trap catch was highest in 2008 (19 bull trout) and declined to 7 and 5 fish in 2009 and 2010, respectively. Trap failure due to atypical high flows likely reduced the catch in 2010. Of the total bull trout captured in the UOM River drainage (n=292) only 5.4% (n=16) was from the lower Livingstone River. Of the 16 bull trout captured and tagged at the lower Livingstone River, no fish were recaptured between 2008 and 2010. A total of 13 bull trout were recaptured in the lower Livingstone River that originated from other spawning tributaries in the UOM River drainage; 10 from Hidden Creek (including 2 fish consecutively recaptured), 2 from Racehorse Creek, and 1 from Dutch Creek.

4.2.2 Spawning behavior

As we did not recapture any Livingstone River bull trout, we could not identify the spawning behaviour or migratory patterns expressed by this bull trout subpopulation. However, our recapture data for migratory bull trout from other spawning tributaries (n=13) suggests that the lower Livingstone River functions as staging habitat during migration or perhaps an overwinter refuge.

We captured lower Livingstone River bull trout during all weeks of the spawning season; however, we captured most of the upstream migrating fish from other spawning tributaries starting in mid-September (Appendix 6). In 2008 and 2010, bull trout began their migration when the average water temperature cooled below 9°C; in 2009, water temperature did not have an apparent effect on fish movements.

4.2.3 Redd survey

In 2008 and 2010, we identified 26 redds and 3 redds respectively, directly upstream from the mouth of Deep Creek. We did not observe redds in this reach in 2009 (Figure 4). Redds were located in a single gravel bed free of cover. We did not observe spawning activity during our surveys throughout the lower Livingstone River.

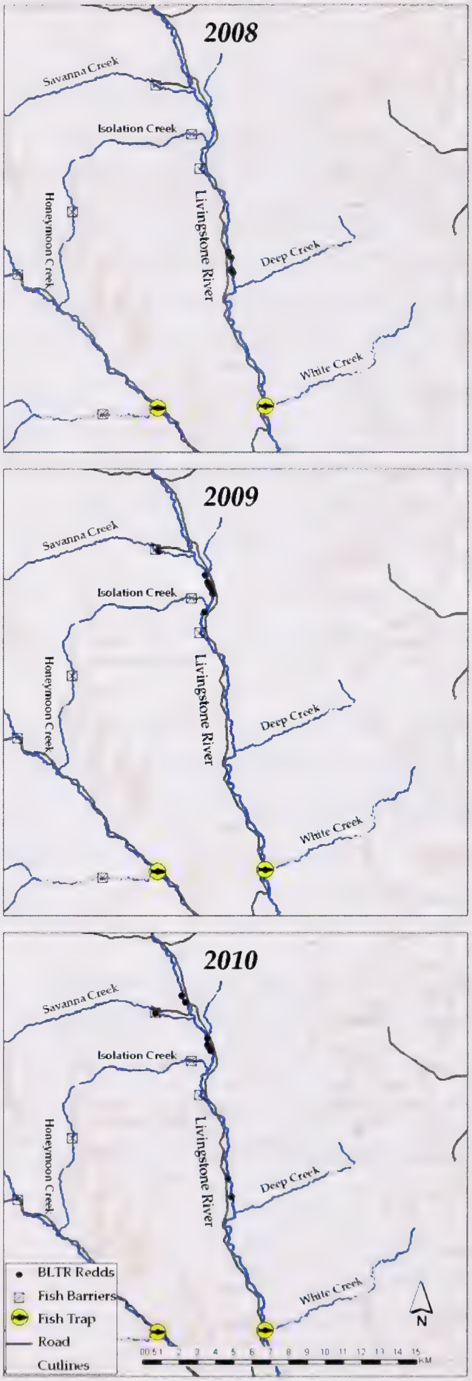

Figure 4. Distribution of bull trout (BLTR) redds observed in the lower and upper Livingstone River, 2008 - 2010.

In 2009, we observed a total of 41 redds between the mouths of Isolation Creek and Savanna Creek, a distance of 5.1 km. Within the same reach, we identified 15 redds in 2010 prior to the high stream flows. Most redds were established along the margins of the stream channel where overhanging vegetation and/or woody debris was present. The remainder of redds were observed in the centre of the stream channel, concealed under woody debris or established in deep water. We also discovered redds along the upstream end of an active beaver dam, located approximately 30 m upstream from the Isolation Creek bridge crossing.

4.2.4 *Size structure*

Average fork length and weight varied slightly between 2009 and 2010, but was substantially lower in 2008 (Table 4; Appendix 7).

Table 4. Summary of measurements of bull trout captured in the lower Livingstone River, 2008 – 2010.

Year	Fork length (mm)		Weight (g)		n
	Mean (± SD)	Range	Mean (± SD)	Range	
2008	550.9 ± 106.7	333 - 680	1656.5 ± 730.5	350 - 2800	19
2009	596.6 ± 48.5	525 - 671	2150.0 ± 476.5	1300 - 2150	7
2010	594.2 ± 54.0	543 - 660	2210.0 ± 627.9	1450 - 3000	5

Sex ratios of bull trout captured in the lower Livingstone River varied between trapping years, although true representation of the actual sex ratios was not possible because of the high number of undetermined fish (Table 5). Males appeared to outnumber females during the 2009 and 2010 trapping years, but were less abundant than females in the 2008 trapping year.

Table 5. Sex distribution of bull trout captured in the lower Livingstone River, 2008 - 2010.

Sex	2008	2009	2010
Male	4	4	3
Female	7	1	1
Undetermined	8	2	1
Total	19	7	5

4.3 Racehorse Creek

4.3.1 Fish trap catch

We captured a total of 32 migratory adult bull trout in the Racehorse Creek fish trap between 2008 and 2010. We captured 15 bull trout in 2008, 8 in 2009, and 9 in 2010. The lower fish catch in 2010 was likely a result of the trap failure. Of the 32 bull trout captured in Racehorse Creek, 28 were tagged at Racehorse Creek, and the remaining 4 fish originated from other tributaries throughout the drainage. Approximately 9.6% of the total fish trap catch from this study was captured at Racehorse Creek.

4.3.2 Spawning behavior

We experienced low recapture rates in Racehorse Creek. Of the 28 bull trout captured, 2 fish were recaptured at least once since 2008. In 2009, we recaptured 2 Racehorse Creek bull trout and in 2010, 1 of these fish was recaptured a second time. Both these fish were repetitive spawners as they were captured in two or more years consecutively.

In all three trapping years, we captured post-spawn bull trout in the fish trap during the month of September (Appendix 8). Bull trout began their post-spawn migration when average water temperatures cooled below 10°C.

4.3.3 Migratory patterns

Over the duration of the study we identified several drainage-wide migration events that connected bull trout from Racehorse Creek to other spawning tributaries. During

2008, we identified 2 fish from Hidden Creek that migrated into Racehorse Creek; 1 fish was tagged in Hidden Creek in 2007, and the other fish was tagged in Hidden Creek earlier that season. This migration pattern was repeated by another fish that was tagged in Hidden Creek in 2008 and recaptured in Racehorse Creek in 2009. In 2010, we recaptured 1 bull trout in Racehorse Creek that had been previously tagged in Dutch Creek in 2008. In 2008, we tagged 1 female bull trout in Racehorse Creek, recaptured the same fish later in the spawning season in the lower Livingstone River, and recaptured it a second time in Racehorse Creek in 2009. A second Racehorse Creek bull trout tagged in 2008 was recaptured in the lower Livingstone River later in 2008.

4.3.4 Redd survey

In 2008 and 2009, we conducted redd surveys in Racehorse Creek between the fish trap and the north and south forks but did not observe any redds. In 2010, we observed five redds grouped downstream of a major logjam that was likely a fish barrier (Figure 5). These redds were observed beneath vegetation or large woody debris, and situated in gravel substrate. Following high flows in 2010, two of the five redds were washed out.

In 2009 and 2010, we observed 21 and 13 bull trout redds respectively, throughout South Racehorse Creek, approximately 4 km downstream from the Atlas Road bridge crossing. This reach is characterized by its relatively narrow channel and marginal flow and is likely unsuitable for larger adult bull trout. We noticed all redds were situated in run sections free of cover, in gravel substrate. In 2010 we noticed one redd was washed out due to high flows. Historically, North Racehorse Creek is documented as a bull trout spawning reach (Gerrand and Watmough 1996; Gerrand and DeRosa 1997) however, we did not detect any redds during our surveys. Within this reach, we observed the stream channel to be relatively shallow with numerous log jams and silty substrate which suggests that this reach is no longer suitable bull trout spawning habitat.

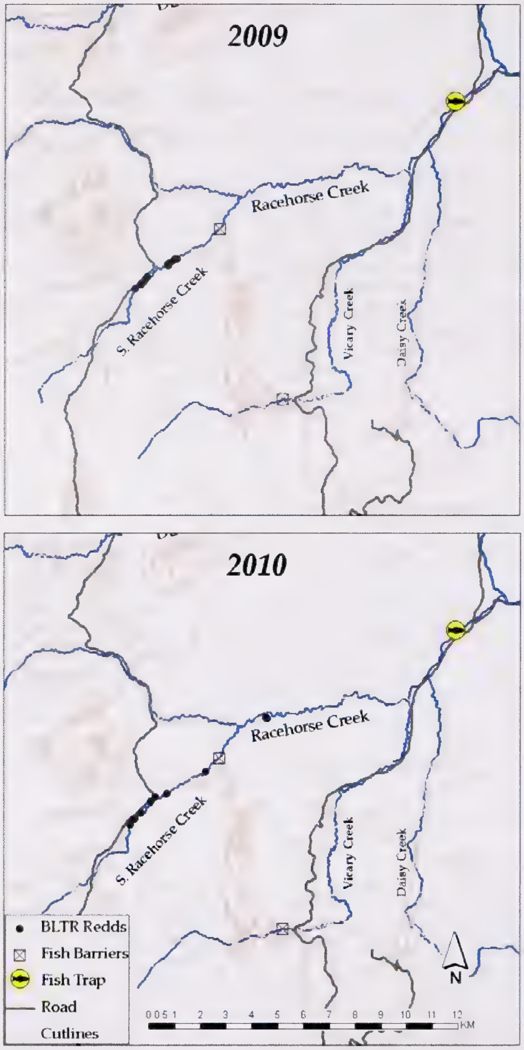

Figure 5. Distribution of bull trout (BLTR) redds observed in Racehorse Creek, 2009 - 2010.

4.3.5 *Size structure*

We observed a slight variation in average fish size and size class between trapping years at Racehorse Creek with the largest average fork length and weight in 2009 (Table 6; Appendix 9).

Table 6. Summary of measurements of bull trout captured in Racehorse Creek, 2008 – 2010.

Year	Fork length (mm)		Weight (g)		n
	Mean (±SD)	Range	Mean (±SD)	Range	
2008	560.1 ± 84.6	434 - 693	1663.3 ± 597.5	700 - 2950	15
2009	643.3 ± 60.0	575 - 758	2725.0 ± 995.0	1900 - 4900	8
2010	551.7 ± 71.2	468 - 673	1750.0 ± 721.5	950 - 2900	9

True representation of the bull trout sex ratio in Racehorse Creek was invalid because of the high number of fish of undetermined sex (Table 7). Of those fish in which the sex could be determined, sex ratios varied considerably in Racehorse Creek between trapping years.

Table 7. Sex distribution of bull trout captured in Racehorse Creek, 2008 - 2010.

Sex	2008	2009	2010
Male	1	3	2
Female	6	4	2
Undetermined	8	1	5
Total	15	8	9

4.4 Dutch Creek

4.4.1 *Fish trap*

We captured a total of 33 migratory adult bull trout in Dutch Creek; 10 fish in 2008, 4 in 2009, and 19 in 2010. It is likely that we missed several fish during the three-day period when the fish trap failed in 2010. A total of 25 fish were captured and tagged in the

Dutch Creek trap, 2 fish originated from Hidden Creek. The Dutch Creek bull trout capture constituted 10.0% of the total fish trap catch in the UOM River drainage.

4.4.2 *Spawning behavior*

Dutch Creek bull trout recapture rates were minimal; only 1 fish was recaptured in 2008 and 3 fish in 2009. These fish exhibited both repetitive and non-repetitive (alternate-year) spawning behaviour.

Over three years of trapping, the Dutch Creek bull trout post-spawn migration occurred throughout the month of September (Appendix 10). Fish were captured evenly throughout this period when the average stream temperature dropped below 9°C.

4.4.3 *Migratory patterns*

One fish tagged in Dutch Creek in 2008, was recaptured in the Livingstone River later the same season, and recaptured a second time in Dutch Creek in 2010. Another fish tagged in Dutch Creek in 2008 was recaptured in Racehorse Creek in 2010.

4.4.4 *Redd survey*

We observed 23 redds in upper Dutch Creek in 2008 (Figure 6). The highest redd density was observed in the upper reach of Dutch Creek, both upstream and downstream of the Atlas Road bridge crossing. Gerrand and Watmough (1996) and Gerrand and DeRosa (1997) also observed bull trout redds in this reach. In 2009, we extended our redd surveys throughout Dutch Creek and located 67 redds. Prior to the high flows, we conducted redd surveys in 2010 and observed 31 redds in the upper reach and 1 redd in the lower reach, approximately 3 km upstream from the fish trap. Following flooding, we resurveyed previous transects and discovered several new bull trout redds, and also found 2 pre-existing redds had been washed out.

We determined spawning occurred in Dutch Creek throughout the month of September. Redds in Dutch Creek were located where groundwater inflow was present. The majority of redds were situated in gravel substrate, under woody debris, overhanging vegetation or undercut banks. A large logjam was observed in Dutch Creek and in 2009

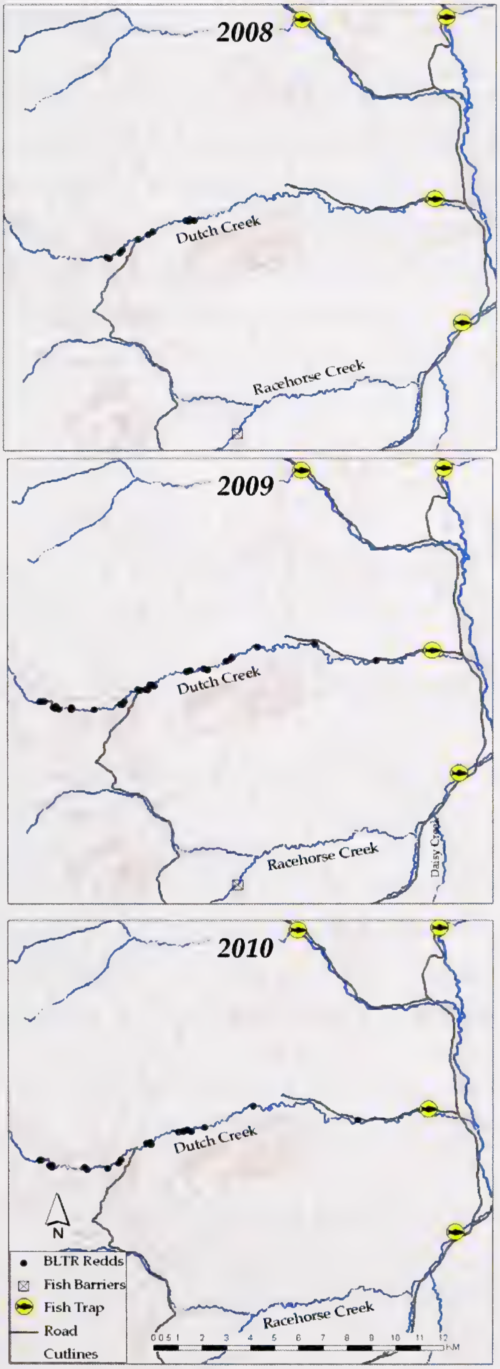

Figure 6. Distribution of bull trout (BLTR) redds observed in Dutch Creek, 2008 - 2010.

and 2010, several redds were located immediately downstream of this logjam suggesting that spawning fish could not find a passage and were forced to spawn in this area.

The greatest redd density in Dutch Creek was observed immediately upstream of the Atlas Road bridge crossing, where groundwater input and subsurface flow was consistent. Throughout this reach, heavy loads of fine sediment were observed accumulating in the stream channel and settling on top of the bull trout redds. This sedimentation is most likely a result of the dense network of off-highway vehicle trails that have degraded and eroded adjacent stream banks releasing sediment into the stream and is a threat to the survival of bull trout eggs downstream.

4.4.5 *Size structure*

Average fork length and weight of fish captured in Dutch Creek varied slightly throughout the study period with the highest values in 2009 (Table 8; Appendix 11).

Table 8. Summary of measurements of bull trout captured in Dutch Creek, 2008 – 2010.

Year	Fork length (mm)		Weight (g)		
	Mean (±SD)	Range	Mean (±SD)	Range	n
2008	598.9 ± 48.2	518 - 670	1955.0 ± 531.0	1200 - 2750	10
2009	622.5 ± 50.1	581 - 683	2250.0 ± 558.3	1600 - 2850	4
2010	582.7 ± 62.1	455 - 652	1809.2 ± 530.3	950 - 2550	19

Female bull trout outnumbered males in our 2008 catch. The sex ratio between females and males was more even in both 2009 and 2010 (Table 9).

Table 9. Sex distribution of bull trout captured in Dutch Creek, 2008 - 2010.

Sex	2008	2009	2010
Male	1	2	8
Female	6	2	9
Undetermined	3	0	2
Total	10	4	19

4.5 Additional redd surveys

In 2009 and 2010 (prior to high flows) we conducted redd surveys in the UOM River and observed 21 redds and 6 redds (prior to flooding), respectively (Figure 7). Throughout the duration of these surveys, we observed several adult bull trout actively spawning during the first half of September. We observed most redds in areas lacking cover along the river's margins. Redds were common in medium-sized gravel that remained clear of algae growth and silt throughout the fall.

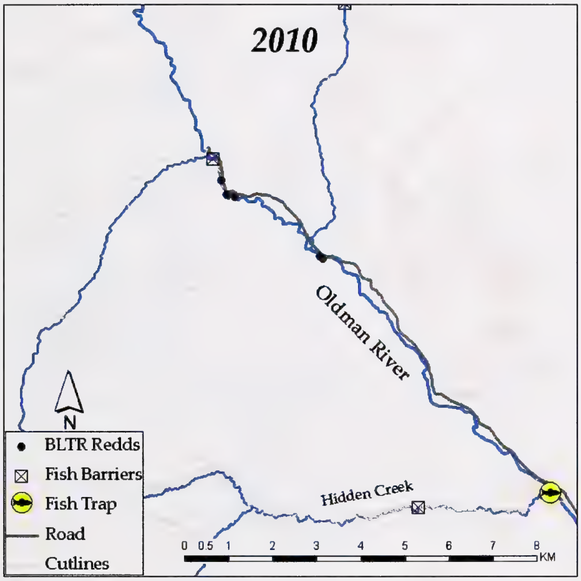

Figure 7. Distribution of bull trout (BLTR) redds observed in the upper Oldman River, 2009 - 2010.

Commencing in 2009, redd surveys were conducted for 1.5 km in Savanna Creek where we observed 1 redd each in 2009 and 2010 (Figure 8). During both survey years, we observed several bull trout (approximately 300 mm FL) in Savanna Creek in the plunge pool below the falls.

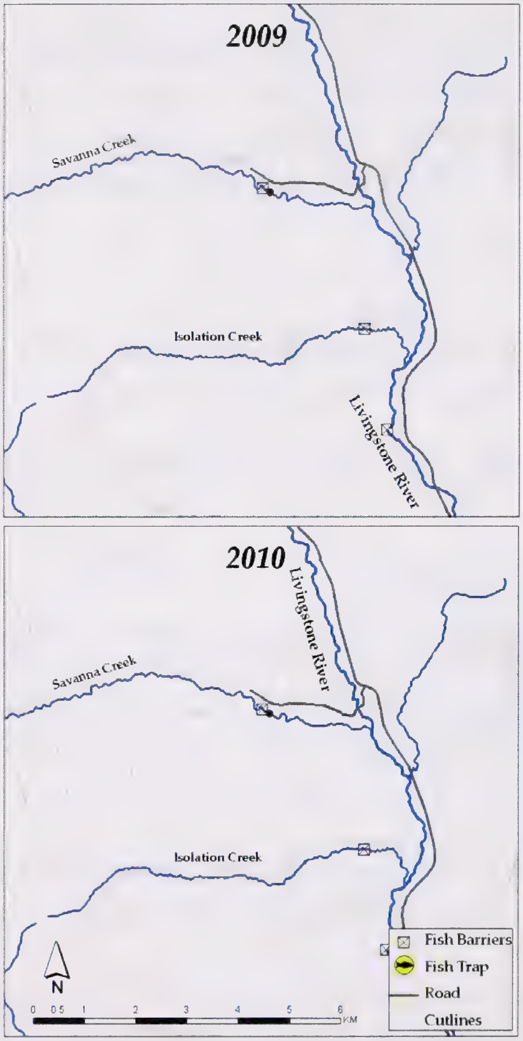

Figure 8. Distribution of bull trout (BLTR) redds observed in Savanna Creek, 2009 - 2010.

In 2009 and 2010, redd surveys were conducted in Daisy Creek for 5 km upstream of the mouth. No redds were observed in 2009 but 2 redds were observed in 2010, prior to the high flows (Figure 9). During both survey years, we observed several bull trout inhabiting the same large pool in the canyon.

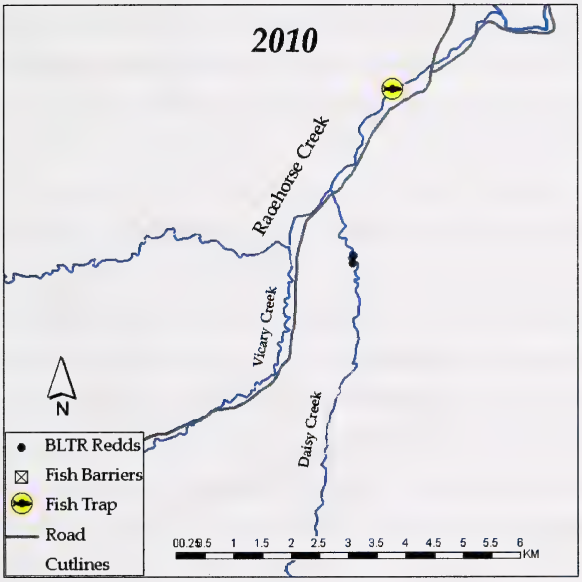

Figure 9. Distribution of bull trout (BLTR) redds observed in Daisy Creek, 2010

In 2009, we conducted a redd survey from the mouth of Mean Creek to the HWY 940 culvert crossing but did not detect any redds. As the culvert appeared to be an impassable barrier, we did not complete redd surveys upstream of the culvert.

We conducted one redd survey in Isolation Creek in 2009, for 500 m upstream of the mouth, but did not detect any redds or spawning activity throughout this stream. We determined the stream was unsuitable for bull trout spawning because of the undefined stream channel and unsuitable stream flow.

5.0 DISCUSSION

It is evident that the Hidden Creek bull trout sub-population is the largest migratory bull trout population in the UOM River drainage. The remainder of the bull trout migratory population is from Dutch Creek, Racehorse Creek, and the Livingstone River (in order of importance). Warnock (2008) identified the same population trend and attributed it to the variable accessibility of spawning habitat. He speculated that the presence of migratory obstructions in some of the tributaries, such as seasonal barriers, limits the number of fish successfully spawning, thus producing fewer migrants.

Spawning habitat in Hidden Creek is relatively accessible to bull trout, as most spawning occurs within the first 4 km of the tributary. Hidden Creek Falls creates a definite seasonal fish barrier and limits migratory fish from spawning upstream. With the exception of a few stream-resident bull trout, most bull trout in the Hidden Creek sub-population are migratory, spawning in Hidden Creek during the fall and overwintering in various tributaries and mainstem channels throughout the UOM River drainage. Hidden Creek is therefore vital to the long-term persistence of bull trout in the UOM River drainage.

The decline in fish trap catch rates we observed in the course of the study may be attributed to several factors. Trap avoidance behaviour would explain declining catches however, the proportion of recaptures in Hidden Creek increased over the course of the study indicating trap avoidance was not widespread. We also found no evidence of a decrease in the fish catch to redd ratio, which would be expected if captured fish were avoiding the trap. While unlikely, if trap avoidance did occur during our trapping efforts, then catchability of marked and unmarked fish would have been unequal.

A more likely explanation is that the decline in catch rates is a result of the variability in the frequency of bull trout spawning. Johnston and Post (2009) identified a density-dependent response in which the number of bull trout spawning in consecutive years decreased as the density of adult fish increased. Our trapping and recapture data suggests that a similar density-dependant response may be occurring in Hidden Creek, since 14% of the catch were alternate-year spawners and 65% were single-year spawners.

The Livingstone River sub-population contributed the least number of bull trout migrants, which may be due to poor accessibility to spawning habitat. Downstream of the Livingstone falls, suitable bull trout spawning habitat was minimal and likely reflected in our low catch rates. The lower reach of the Livingstone River is comprised of numerous, large deep pools which may be suitable overwintering habitat for adult bull trout. It is possible that our fish catch failed to represent the actual migratory sub-population, as some post-spawn bull trout might overwinter upstream of the trap. Our recapture data suggests that the lower Livingstone River provides overwintering habitat for adult bull trout from Hidden Creek, Racehorse Creek, and Dutch Creek. Redds observed in the Livingstone River, upstream of the falls indicate the presence of a stream-resident bull trout population confirming the observations of Warnock (2008).

Our Racehorse Creek trapping and redd data indicates the presence of both migratory and stream-resident bull trout, given that the number of redds exceeded the number of fish caught. Redds observed in South Racehorse Creek were likely produced by stream-resident bull trout, as the small channel size and low flow we observed in this stream would be unsuitable for larger, migratory bull trout. Access to South Racehorse Creek is also limited for migratory bull trout, due to a set of waterfalls approximately 2 km upstream from the stream's mouth. Access to Racehorse Creek may also be limited by a large logjam approximately 1 km downstream of the confluence of South Racehorse and North Racehorse creeks that was a fish barrier. The Racehorse Creek bull trout sub-population comprises a small proportion of the migrants in the UOM drainage. Our recapture data suggests that Racehorse Creek also provides overwintering habitat for post-spawn migratory bull trout from Hidden Creek.

We observed a number of similarities between Dutch Creek and Racehorse Creek. Based on our data, we identified both migratory and stream-resident bull trout populations in Dutch Creek, since the number of redds far exceeded our fish catch. A large logjam observed in Dutch Creek has likely blocked fish migration, resulting in an isolated population. Most redds were observed upstream of this barrier and it is likely that the majority were created by stream-resident bull trout. However, during redd surveys, we observed relatively large (>400 mm FL) bull trout spawning upstream of the logjam that were not caught in the fish trap. It is uncertain whether these fish were migratory fish that have become isolated from the downstream population or stream-resident fish.

Catch totals and redd densities all underscore the importance of Hidden Creek as a spawning stream for the migratory bull trout population of the UOM River drainage. It is imperative that the spawning habitat in Hidden Creek not become degraded or compromised. It is probable that the Livingstone River, as well as Dutch and Racehorse creeks, once supported larger populations of migratory bull trout but now support stream-resident populations in their headwaters and receive limited use by migratory bull trout.

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7.0 APPENDICES

Appendix 1. Locations and dates fish traps were operational in the UOM River drainage, 2007 – 2010.

Waterbody	Easting	Northing	2007	2008	2009	2010
Hidden Creek	684392	5530797	Jul 31 - Oct 2	Aug 25 - Oct 12	Aug 24 - Oct 6	Aug 24 - Oct 4
Livingstone River	686315	5539595	--	Aug 27 - Oct 12	Aug 25 - Oct 6	Aug 27 - Sep 21
Racehorse Creek	686968	5525934	--	Aug 26 - Oct 12	Aug 26 - Oct 7	Aug 26 - Sep 21
Dutch Creek	685857	5531461	--	Aug 25 - Oct 12	Aug 24 - Oct 6	Aug 24 - Oct 4

Appendix 2. Redd survey data collected from bull trout spawning tributaries in the UOM River drainage, 2008 - 2010 (mean ± SD).

Waterbody	Year	Survey period	No. of redds	Redd length (cm)		Redd width (cm)	
				Mean (±SD)	Range	Mean (±SD)	Range
Hidden Creek	2008	Sep 2 – Oct 12	108	126.9 + 43.1	40 - 300	62.4 – 20.5	20 - 120
	2009	Aug 29 – Oct 4	75	127.9 + 34.1	70 - 330	58.8 + 15.8	40 - 140
	2010	Aug 26 - Sep13	31	148.8 + 52.3	70 - 320	89.4 + 26.9	40 - 150
Livingstone River	2008	Sep 3 – Oct 4	26	86.5 + 106.7	55 - 140	48.9 + 106.4	30 - 75
	2009	Aug 31 – Sep 22	41	117.0 + 46.0	40 - 280	47.8 + 13.4	25 - 80
	2010	Aug 31 – Sep 26	16	121.9 + 37.5	50 - 180	91.6 + 16.7	30 - 100
Racehorse Creek	2008	Sep 6 – Sep 14	0	--	--	--	--
	2009	Sep 15 – Oct 1	21	127 + 33.6	100 - 320	28.1 + 9.4	15 - 50
	2010	Sep 11 – Oct 1	13	173.5 + 72.6	40 - 180	40.4 + 14.4	20 - 70
Dutch Creek	2008	Sep 4 – Oct 3	25	96.4 + 19.8	70 - 150	48.9 + 11.3	25 - 80
	2009	Sep 3 – Oct 2	25	120.9 + 33.0	50 - 230	47.6 + 15.1	30 - 90
	2010	Aug 30 – Sep 30	32	170.8 + 72.6	80 - 350	85.9 + 29.8	45 - 200

Appendix 2. Continued.

Waterbody	Year	Survey period	No. of redds	Redd length (cm)		Redd width (cm)	
				Mean (±SD)	Range	Mean (±SD)	Range
Oldman River	2009	Sep 19 – Oct 5	21	112.5 ± 21.7	70 - 160	53.8 ± 19.0	30 - 120
	2010	Sep 2 – Oct 2	5	126.0 + 47.2	60 - 190	88.0 + 42.7	50 - 150
Savanna Creek	2009	Sep-20	1	--	100	--	60
	2010	Sep-03	1	--	30	--	20
Daisy Creek	2010	Sep-14	2	245.0 ± 134.4	150 - 340	115.0 ± 7.1	110 - 120

Appendix 3. Bull trout capture history in the UOM drainage, 2007 – 2010. FL = Fork length, HDDN = Hidden Creek, LVGS = Livingstone River, RH = Racehorse Creek, DTCH = Dutch Creek, VCRY = Vicary Creek, Gap = Gap Falls, Wald = Waldron Falls, STN = Station Creek, DSY = Daisy Creek, OLDM = Oldman River, NRH = North Racehorse Creek, SRH = South Racehorse Creek, PRTRD = Upstream of Oldman Reservoir.

			2007				**2008**				**2009**				**2010**			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
1	985161000710648	U	23/8/07	RH	E-fish	735												
2	985161000711807	U	21/8/07	RH	E-fish	305												
3	985161000713305	F													8/9/10	DTCH	Trap	558
4	985161000762880	U	15/9/07	HDDN	Trap	441												
5	985161000762884	U	18/9/07	HDDN	Trap	465												
6	985161000762982	F					14/9/08	HDDN	Trap	434					14/9/10	HDDN	Trap	469
7	985161000763065	U									22/9/09	HDDN	Trap	575				
8	985161000763128	M													3/9/10	LVGS	Trap	562
9	985161000763227	U	11/9/07	HDDN	Trap	510					9/9/09 25/9/09	HDDN LVGS	Trap Trap	541 563				
10	985161000763466	U	19/7/07	GAP	Angle	525												
11	985161000763473	U	19/7/07	GAP	Angle	424												
12	985161000763487	U					2/10/08	LVGS	Trap	350								
13	985161000763575	U	16/9/07	HDDN	Trap	760					25/8/09	HDDN	Trap	778				
14	985161000763589	U	14/8/07	DTCH	E-fish	550												

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
15	985161000763667	U					7/4/08	WALD	Angle	462								
16	985161000763725	M													18/9/10	DTCH	Trap	633
17	985161000763771	U									14/9/09	HDDN	Trap	537				
18	985161000763789	U	13/7/07	WALD	Angle	403												
19	985161000763794	U	1/8/07	VCRY	E-fish	331												
20	985161000763874	U	14/8/07	DTCH	E-fish	525												
21	985161000763883	U					8/9/08	HDDN	Trap	616								
22	985161000763886	U	8/8/07	HDDN	Trap	545												
23	985161000763911	U	21/8/07	RH	E-fish	350												
24	985161000763912	U					10/9/08	DTCH	Trap	531								
25	985161000763983	U									19/9/09	HDDN	Trap	654				
26	985161000764116	U					15/9/08	HDDN	Trap	505								
27	985161000764244	U					15/9/08	HDDN	Trap	458								
28	985161000764327	U													11/9/10	HDDN	Trap	446
29	985161000764348	U	30/7/07	GAP	Angle	396												
30	985161000764469	U									26/9/09	LVGS	Trap	625				

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
31	985161000764476	U									8/9/09	RH	Trap	575				
32	985161000764479	U									9/9/09	HDDN	Trap	494				
33	985161000764486 985161000764486	U					6/9/08 15/9/08	HDDN RH	Trap Trap	588 578								
34	985161000764560	U	4/9/07	HDDN	Trap	512	31/8/08	HDDN	Trap	529	12/9/09	HDDN	Trap	550				
35	985161000764561 985161000764561	F	7/9/07	HDDN	Trap	578	12/9/08 3/10/08	HDDN LVGS	Trap Trap	579 580					8/9/10	HDDN	Trap	594
36	985161000764574	U	10/9/07	HDDN	Trap	551												
37	985161000764581	U	15/9/07	HDDN	Trap	666												
38	985161000764605	U									7/9/09	HDDN	Trap	490				
39	985161000764702 985161000764702	U	23/8/07	HDDN	Trap	660					23/9/09 11/6/09	HDDN GAP	Trap Angle	710 701				
40	985161000764703	U	12/7/07	DTCH	E-fish	610												
41	985161000764707	U	13/7/07	WALD	Angle	433												
42	985161000764719	U	23/9/07	HDDN	Trap	418												
43	985161000764815	M													10/9/10	DTCH	Trap	532
44	985161000764942	U	18/7/07	GAP	Angle	363												
45	985161000764974 985161000764974	M	27/8/07	HDDN	Trap	618	18/9/08	HDDN	Trap	646					27/9/10	HDDN	Trap	652

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
46	985161000764977	M													20/9/10	HDDN	Trap	422
47	985161000765069	U					17/9/08	HDDN	Trap	506.00								
48	985161000765096 985161000765096	U					18/9/08 4/10/08	HDDN LVGS	Trap Trap	679 680								
49	985161000765100	U	29/8/07	HDDN	Trap	560	8/9/08	HDDN	Trap	572								
50	985161000765201	U	13/7/07	WALD	Angle	482												
51	985161000765227	M	10/9/07	HDDN	Trap	558	10/9/08	HDDN	Trap	577	29/8/09	DTCH	Trap	582	10/9/10	HDDN	Trap	614
52	985161000765235	U	1/8/07	GAP	Angle	505												
53	985161000765328	U	14/8/07	DTCH	E-fish	740												
54	985161000765335	U					26/9/08	LVGS	Trap	638								
55	985161000765336	U	31/7/07	STN	E-fish	391												
56	985161000765434	M					10/9/08	HDDN	Trap	678					13/9/10	HDDN	Trap	700
57	985161000765444	M	6/9/07	HDDN	Trap	631									26/8/10	LVGS	Trap	660
58	985161000765448	F	1/9/07	HDDN	Trap	475									2/9/10	HDDN	Trap	510
59	985161000765458 985161000765458	U					10/9/08 13/9/08	HDDN LVGS	Trap Trap	479 476								
60	985161000765565	U	26/9/07	HDDN	Trap	685												

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
61	985161000765599	U	25/9/07	HDDN	Trap	620												
62	985161000765602	U													12/9/10	HDDN	Trap	556
63	985161000765684	F	16/9/07	HDDN	Trap	445					12/9/09	HDDN	Trap	494	6/9/10	HDDN	Trap	490
64	985161000765690	U													14/9/10	RH	Trap	535
65	985161000765794	U	18/7/07	GAP	Angle	421												
66	985161000765836	M	11/9/07	HDDN	Trap	551					11/9/09	HDDN	Trap	588	4/9/10	HDDN	Trap	585
67	985161000765955	U	10/7/07	VCRY	E-fish	327												
68	985161000765956	F	6/9/07	HDDN	Trap	568	7/9/08	HDDN	Trap	567					7/9/10	HDDN	Trap	591
69	985161000766037	F									19/9/09	HDDN	Trap	663	13/9/10	HDDN	Trap	662
70	985161000766053	U													7/9/10	HDDN	Trap	633
71	985161000766177	U	6/9/07	HDDN	Trap	487												
72	985161000766307	U	7/9/07	HDDN	Trap	308												
73	985161000766440	M									5/9/09	HDDN	Trap	649	2/9/10	HDDN	Trap	655
74	985161000766685	U	25/9/07	OLDM	E-fish	455												
75	985161000766705	F					18/9/08	HDDN	Trap	437					10/9/10	HDDN	Trap	498

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
76	985161000766708	U	10/9/07	HDDN	Trap	716												
77	985161000766780	U	13/8/07	RH	E-fish	355												
78	985161000766830	F					9/9/08	HDDN	Trap	662					6/9/10	HDDN	Trap	684
79	985161000767031	U	8/9/07	HDDN	Trap	540	11/9/08	HDDN	Trap	575								
80	985161000767039	U					13/9/08	HDDN	Trap	638								
81	985161000767070	U	10/9/07	HDDN	Trap	562												
82	985161000767196	U					6/5/08	WALD	Angle	534								
83	985161000767271	U	5/8/07	HDDN	Trap	436												
84	985161000767381	U	18/7/07	GAP	Angle	396												
85	985161000767386	U					12/9/08	HDDN	Trap	525								
86	985161000767394	U					21/9/08	RH	Trap	442								
87	985161000767531	M					24/9/08	HDDN	Trap	514					12/9/10	HDDN	Trap	523
88	985161000767540 985161000783022	U	Same Fish				12/9/08	RH	Trap	636								
89	985161000767607	U	19/8/07	HDDN	Trap	635	19/9/08	HDDN	Trap	633								
90	985161000767614	U					12/9/08	HDDN	Trap	565								

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
91	985161000767654	U	13/7/07	WALD	Angle	450												
92	985161000767716	F	1/9/07	HDDN	Trap	678	7/9/08	HDDN	Trap	690					9/9/10	HDDN	Trap	704
93	985161000767720	U	12/9/07	HDDN	Trap	584												
94	985161000767846	U					20/9/08	RH	Trap	521								
95	985161000767863	U					15/9/08	HDDN	Trap	543								
96	985161000768126	M													14/9/10	HDDN	Trap	477
97	985161000768305	U	12/9/07	HDDN	Trap	635												
98	985161000768315	F													14/9/10	DTCH	Trap	625
99	985161000768399	M													7/9/10	HDDN	Trap	483
100	985161000768487	U	3/8/07	HDDN	Trap	620												
	985161000768487		21/9/07	LVGS	E-fish	No Data												
101	985161000768560	U	30/8/07	DSY	E-fish	336												
102	985161000768609	U	6/9/07	HDDN	Trap	527					9/9/09	HDDN	Trap	545				
103	985161000768615	U					27/8/08	HDDN	Trap	420								
104	985161000768660	U	8/9/07	HDDN	Trap	640												
105	985161000768664	U	8/9/07	HDDN	Trap	435												

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
106	985161000766711	M													19/9/10	HDDN	Trap	555
107	985161000768802	U	4/9/07	HDDN	Trap	441					17/9/09	HDDN	Trap	471				
108	985161000769680	U	4/8/07	HDDN	Trap	461												
109	985161000770684	U					9/4/08	PRTRD	Angle	475								
110	985161000771314	U					12/9/08	HDDN	Trap	421	11/9/09	HDDN	Trap	450	10/9/10	HDDN	Trap	472
111	985161000771320	U									31/8/09	HDDN	Trap	477				
112	985161000771528	U	26/8/07	HDDN	Trap	555												
113	985161000771784	U					8/5/08	GAP	Angle	460								
114	985161000772993	U					10/9/08	HDDN	Trap	492								
115	985161000773368	U													16/9/10	RH	Trap	468
116	985161000773983	U					13/9/08	LVGS	Trap	333								
117	985161000774153	U													25/8/10	HDDN	Trap	602
118	985161000775282	U	4/9/07	HDDN	Trap	660												
119	985161000775282?	U	12/7/07	DTCH	E-fish	565												
120	985161000775283 985161000775283	U					2/9/08 5/9/08	HDDN LVGS	Trap Trap	669 668	9/9/09 16/9/09	HDDN LVGS	Trap Trap	676 671				

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
121	985161000775485	U					5/9/08	DTCH	Trap	611	6/9/09	DTCH	Trap	645				
122	985161000775681	U	19/7/07	GAP	Angle	578												
123	985161000775789	M					10/9/08	HDDN	Trap	633	2/9/09	RH	Trap	646	21/9/10	HDDN	Trap	652
124	985161000775796	U					22/9/08	RH	Trap	434								
125	985161000775802	U	3/9/07	HDDN	Trap	725	12/9/08	HDDN	Trap	724								
126	985161000775905	U													29/9/10	DTCH	Trap	534
127	985161000776004	U	11/7/07	OLDM	E-fish	592					21/9/09	HDDN	Trap	635				
128	985161000776022	U	26/8/07	HDDN	Trap	434												
129	985161000776121	U													10/9/10	HDDN	Trap	473
130	985161000776143	M													21/9/10	HDDN	Trap	616
131	985161000776256	U													15/9/10	RH	Trap	553
132	985161000776492	F									8/9/09	HDDN	Trap	636	15/9/10	DTCH	Trap	631
133	985161000776503	U	16/9/07	HDDN	Trap	695												
134	985161000776629	U					10/9/08	HDDN	Trap	624								
135	985161000776857	U	30/7/07	GAP	Angle	429												

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
136	985161000776985	M													15/9/10	DTCH	Trap	539
137	985161000776992	U	16/9/07	HDDN	Trap	542												
138	985161000777112	U	14/8/07	DTCH	E-fish	454												
139	985161000777118	U					13/9/08	DTCH	Trap	568								
140	985161000777132	U									11/9/09	HDDN	Trap	469				
141	985161000777235	U					14/9/08	HDDN	Trap	605	17/9/09	HDDN	Trap	625				
142	985161000777247	U	8/9/07	HDDN	Trap	450	10/9/08	HDDN	Trap	462								
143	985161000777481	U	25/7/07	NRH	E-fish	326												
144	985161000777497	U					12/9/08	HDDN	Trap	422								
145	985161000777701	M	16/9/07	HDDN	Trap	489					16/9/09	HDDN	Trap	527	17/9/10	HDDN	Trap	550
146	985161000777710	U	14/9/07	HDDN	Trap	576					10/9/09	HDDN	Trap	604				
147	985161000777725	U													11/9/10	HDDN	Trap	610
148	985161000777939	M					13/9/08	HDDN	Trap	472	11/9/09	HDDN	Trap	486	10/9/10	HDDN	Trap	492
149	985161000778068	U	10/9/07	HDDN	Trap	551	10/9/08	HDDN	Trap	551								
150	985161000778076	U	8/9/07	HDDN	Trap	439												

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
151	985161000778458	U	4/9/07	HDDN	Trap	600	2/9/08	HDDN	Trap	623								
152	985161000778474	U					9/9/08	RH	Trap	693								
153	985161000778582	U	9/9/07	HDDN	Trap	505												
154	985161000778598	F	7/8/07	HDDN	Trap	418					12/9/09	HDDN	Trap	437	17/9/10	HDDN	Trap	445
155	985161000778600	F													15/9/10	HDDN	Trap	542
156	985161000778700	M													16/9/10	DTCH	Trap	650
157	985161000778821	U	24/9/07	OLDM	E-fish	507	18/9/08	HDDN	Trap	517								
158	985161000778831	U	16/9/07	HDDN	Trap	520												
159	985161000778842	U					6/5/08	WALD	Angle	449								
160	985161000778846	M													19/9/10	RH	Trap	575
161	985161000779064	U	14/9/07	HDDN	Trap	627					31/8/09	HDDN	Trap	671				
162	985161000779074	U	9/9/07	HDDN	Trap	499												
163	985161000779076	M													13/9/10	HDDN	Trap	645
164	985161000779191	U					11/9/08	RH	Trap	520								
165	985161000779311	F													11/9/10	DTCH	Trap	610

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
166	985161000779411	U													14/9/10	HDDN	Trap	420
167	985161000779417	U									22/9/09	RH	Trap	703				
168	985161000779418	U									20/9/09	LVGS	Trap	525				
169	985161000779528	F									10/9/09	HDDN	Trap	459	13/9/10	HDDN	Trap	471
170	985161000779744	U	20/9/07	HDDN	Trap	405												
171	985161000779747	U					8/9/08	HDDN	Trap	507								
172	985161000780023	U									12/9/09	HDDN	Trap	445				
173	985161000780599	U	8/9/07	HDDN	Trap	530												
174	985161000780656	U					19/9/08	DTCH	Trap	655								
175	985161000780667	U	21/8/07	HDDN	Trap	495												
176	985161000780684	U									11/9/09	HDDN	Trap	675				
177	985161000780788	U	18/9/07	HDDN	Trap	370												
178	985161000780789	U					19/9/08	DTCH	Trap	518								
179	985161000780797	U	5/9/07	HDDN	Trap	584												
180	985161000780825	U									17/9/09	HDDN	Trap	477				

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
181	985161000780838	U					9/9/08	RH	Trap	580								
182	985161000780866	U	13/9/07	HDDN	Trap	535									10/9/10	HDDN	Trap	599
183	985161000780890	M					14/9/08	HDDN	Trap	446	17/9/09	HDDN	Trap	478	27/9/10	HDDN	Trap	480
184	985161000780930	U									26/8/09	LVGS	Trap	574				
185	985161000780933	U	1/8/07	GAP	Angle	480												
186	985161000780944	U	13/7/07	WALD	Angle	408												
187	985161000780964	U					8/9/08	HDDN	Trap	515								
188	985161000781015	M													13/9/10	HDDN	Trap	511
189	985161000781080	U	6/9/07	HDDN	Trap	651												
190	985161000781083	U	15/9/07	HDDN	Trap	485												
191	985161000781084	F	17/8/07	HDDN	Trap	513	10/9/08	HDDN	Trap	521					11/9/10	HDDN	Trap	525
192	985161000781086	U													15/9/10	HDDN	Trap	483
193	985161000781101	U					29/8/08	HDDN	Trap	321	14/9/09	HDDN	Trap	373				
194	985161000781117	U					7/5/08	WALD	Angle	471								
195	985161000781138	M													09/19/10	RH	Trap	485

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
196	985161000781172	U													1/10/10	HDDN	Trap	457
197	985161000781197	U	6/9/07	HDDN	Trap	650												
198	985161000781258	M					16/9/08	HDDN	Trap	540					22/9/10	HDDN	Trap	553
199	985161000781279	U	8/9/07	HDDN	Trap	748												
200	985161000781328	M	12/9/07	HDDN	Trap	438					17/9/09	HDDN	Trap	468	7/9/10	HDDN	Trap	482
201	985161000781343	M					8/9/08	HDDN	Trap	435	18/9/09	HDDN	Trap	461	15/9/10	HDDN	Trap	491
202	985161000781352	M													18/9/10	DTCH	Trap	570
203	985161000781354	U	24/9/07	OLDM	E-fish	596												
204	985161000781159	M													9/9/10	HDDN	Trap	434
205	985161000781412	U									20/9/09	HDDN	Trap	660				
206	985161000781474	U					2/9/08	RH	Trap	487								
207	985161000781574	U	18/7/07	GAP	Angle	490												
208	985161000781717	U	16/8/07	HDDN	Trap	520												
209	985161000781739	U	13/8/07	RH	E-fish	426												
210	985161000781741	M					16/9/08	HDDN	Trap	630					10/9/10	HDDN	Trap	655

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
211	985161000781773	U	12/7/07	DTCH	E-fish	535												
212	985161000781779	U	25/9/07	HDDN	Trap	653												
213	985161000781837	U	21/8/07	RH	E-fish	545												
214	985161000781879	U	18/7/07	GAP	Angle	420												
215	985161000781889	U	3/9/07	HDDN	Trap	618												
216	985161000781982	F													13/9/10	DTCH	Trap	642
217	985161000782067	U					7/9/08	HDDN	Trap	558								
218	985161000782108	U	9/9/07	HDDN	Trap	481												
219	985161000782136	U	13/7/07	WALD	Angle	379												
220	985161000782138 985161000782138	M	25/9/07	HDDN	Trap	638	8/9/08 20/9/08	HDDN LVGS	Trap Trap	640 641					10/9/10 7/9/10	HDDN LVGS	Trap Trap	645 645
221	985161000782186	U	12/8/07	HDDN	Trap	330												
222	985161000782220	U					22/9/08	HDDN	Trap	733								
223	985161000782309	U									16/9/09	HDDN	Trap	524				
224	985161000782425	U	14/9/07	HDDN	Trap	640												
225	985161000782426	U									9/9/09	HDDN	Trap	488				

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
226	985161000782531	U					27/9/08	HDDN	Trap	700								
227	985161000782602	U					16/9/08	HDDN	Trap	676								
228	985161000782792	U	2/9/07	HDDN	Trap	528					9/9/09	HDDN	Trap	548				
229	985161000782818	U	9/9/07	HDDN	Trap	460	13/9/08	HDDN	Trap	471								
230	985161000782822	U					14/9/08	DTCH	Trap	605								
231	985161000782841	F					9/9/08	HDDN	Trap	594	17/9/09	HDDN	Trap	616	15/9/10	DTCH	Trap	650
232	985161000782916	U	21/8/07	RH	E-fish	480												
233	985161000782923	U	13/8/07	RH	E-fish	610												
234	985161000783102	U	24/9/07	OLDM	E-fish	633												
235	985161000783118	U					15/9/08	HDDN	Trap	487								
236	985161000783151	M	4/9/07	HDDN	Trap	649									11/9/10	HDDN	Trap	660
237	985161000783160	U	3/9/07	HDDN	Trap	636	7/9/08	HDDN	Trap	642								
238	985161000783163	M					17/9/08	HDDN	Trap	615					13/9/10	HDDN	Trap	645
239	985161000783234	M					23/9/08	HDDN	Trap	672					20/9/10	HDDN	Trap	715
240	985161000783267	U	12/9/07	HDDN	Trap	520												

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
241	985161000783279	U	1/8/07	VCRY	E-fish	279												
242	985161000783311	U	25/7/07	NRH	E-fish	321												
243	985161000783347	U	3/9/07	HDDN	Trap	577												
244	985161000783420	F					5/9/08	DTCH	Trap	634					6/9/10	DTCH	Trap	652
245	985161000783424	F	1/9/07	HDDN	Trap	575									13/9/10	HDDN	Trap	579
246	985161000783465	U					14/9/08	HDDN	Trap	655								
247	985161000783507	U	3/9/07	HDDN	Trap	468												
248	985161000783598	U													12/9/10	DTCH	Trap	471
249	985161000783560	U	5/9/07	HDDN	Trap	648												
250	985161000783606	U	12/9/07	HDDN	Trap	481	12/9/08	HDDN	Trap	493								
251	985161000783651	U	30/7/07	GAP	Angle	396.00												
252	985161000783665	U	9/9/07	HDDN	Trap	625	13/9/08	HDDN	Trap	663								
253	985161000783727	U	12/7/07	SRH	E-fish	330												
254	985161000783740	F									17/9/09	HDDN	Trap	426	15/9/10	HDDN	Trap	430
255	985161000783789	U									23/9/09	DTCH	Trap	683				

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
256	985161000783805	U					21/9/08	LVGS	Trap	351								
257	985161000783760	F													8/9/10	DTCH	Trap	510
258	985161000783851	U	15/9/07	HDDN	Trap	640					30/8/09	HDDN	Trap	656				
259	985161000783858	U									17/9/09	HDDN	Trap	490				
260	985161000783862	U	7/9/07	HDDN	Trap	462												
261	985161000783914	U	16/9/07	HDDN	Trap	605												
262	985161000783996	U					18/9/08	HDDN	Trap	691								
263	985161000783997	U					29/8/08	LVGS	Trap	520								
264	985161000784007	U	18/7/07	GAP	Angle	382												
265	985161000784087 985161000784087	U					7/9/08 21/9/08	HDDN LVGS	Trap Trap	570 571								
266	985161000784107	U	19/7/07	GAP	Angle	380												
267	985161000784132	U	1/9/07	HDDN	Trap	528	5/9/08	HDDN	Trap	547	9/9/09	HDDN	Trap	563				
268	985161000784147	U	7/9/07	HDDN	Trap	510												
269	985161000784175	U					7/5/08	PRVTRD	Angle	465								
270	985161000784184	U	6/9/07	HDDN	Trap	521												

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
271	985161000784250	U	26/9/07	LVGS	E-fish	562	31/8/08	LVGS	Trap	567								
272	985161000784253	U	10/9/07	HDDN	Trap	723	12/9/08	HDDN	Trap	731								
273	985161000784254	U	15/9/07	HDDN	Trap	530												
274	985161000784291	U	15/8/07	HDDN	Trap	440					12/9/09	HDDN	Trap	473				
275	985161000784309	U	6/9/07	HDDN	Trap	721					27/9/09	HDDN	Trap	733				
276	985161000784312 985161000784312	U	2/9/07	HDDN	Trap	632	27/8/08 29/9/08	HDDN LVGS	Trap Trap	645 645								
277	985161000784328	U	21/8/07	RH	E-fish	421												
278	985161000784346	M									2/9/09	RH	Trap	758	23/9/10	HDDN	Trap	770
279	985161000784372	U	21/8/07	RH	E-fish	532												
280	985161000784387	U					8/5/08	PRVTRD	Angle	511								
281	985161000784408	M					12/9/08	HDDN	Trap	511					8/9/10	HDDN	Trap	551
282	985161000784435	U					5/9/08	HDDN	Trap	625	15/9/09	LVGS	Trap	628				
283	985161000784468	U									14/6/09	WALD	Angle	544				
284	985161000784479 985161000784479	M					18/9/08 24/9/08	DTCH LVGS	Trap Trap	606 606					13/9/10	DTCH	Trap	623
285	985161000784658	M													15/9/10	DTCH	Trap	616

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
286	985161000784659	F									9/9/09	HDDN	Trap	496	7/9/10	HDDN	Trap	524
287	985161000784715 985161000784715	U					19/9/08 3/10/08	RH LVGS	Trap Trap	639 638								
288	985161000784721	U	18/7/07	GAP	Angle	390												
289	985161000784732	U									22/9/09	RH	Trap	602				
290	985161000784739	U	28/8/07	HDDN	Trap	690					27/9/09	HDDN	Trap	717				
291	985161000784772	U	2/9/07	HDDN	Trap	595					13/9/09	HDDN	Trap	616				
292	985161000784785	U	1/9/07	HDDN	Trap	485												
293	985161000784797	U	14/8/07	DTCH	E-fish	684												
294	985161000784819	U	26/9/07	HDDN	Trap	652												
295	985161000784844	U	1/9/07	HDDN	Trap	528					31/8/09	HDDN	Trap	555				
296	985161000784903	U	22/8/07	RH	E-fish	485												
297	985161000784908	U	3/8/07	HDDN	Trap	467									12/9/10	LVGS	Trap	561
298	985161000784941	F									10/9/09	HDDN	Trap	461	8/9/10	HDDN	Trap	485
299	985161000784955	M													20/9/10	HDDN	Trap	800
300	985161000784966	U					16/9/08	HDDN	Trap	502								

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
301	985161000785008	U	1/9/07	HDDN	Trap	531	4/9/08	HDDN	Trap	541	11/9/09	HDDN	Trap	553				
302	985161000785028	U					17/9/08	HDDN	Trap	470								
303	985161000785047	U	2/9/07	HDDN	Trap	692												
304	985161000785116	F	11/9/07	HDDN	Trap	420									8/9/10	HDDN	Trap	475
305	985161000785118	F									10/9/09	HDDN	Trap	543	8/9/10	HDDN	Trap	557
306	985161000785226	U	12/9/07	HDDN	Trap	439	20/9/08	HDDN	Trap	441					13/9/10	HDDN	Trap	451
307	985161000785281	U	16/9/07	HDDN	Trap	485	9/9/08	HDDN	Trap	490								
308	985161000785311	M	11/7/07	OLDM	E-fish	551					2/9/09	LVGS	Trap	590	15/9/10	HDDN	Trap	594
309	985161000785382	U	10/9/07	HDDN	Trap	482	Sep 11, 1008	HDDN	Trap	485								
310	985161000785429	M	26/8/07	HDDN	Trap	515					17/9/09	HDDN	Trap	550	8/9/10	HDDN	Trap	560
311	985161000785526	F	3/9/07	HDDN	Trap	560									9/9/10	HDDN	Trap	583
312	985161000785545	U	8/8/07	HDDN	Trap	566												
313	985161000785579	U									28/9/08	HDDN	Trap	465.00				
314	985161000785622	U	11/7/07	OLDM	E-fish	438												
315	985161000785659	U	6/9/07	HDDN	Trap	500												

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
316	985161000785676	U	5/8/07	HDDN	Trap	508												
317	985161000785687	U									12/9/09	HDDN	Trap	478				
318	985161000785709	U	19/7/07	RH	E-fish	342												
319	985161000785780	U					23/9/08	DTCH	Trap	670					12/9/10	RH	Trap	673
320	985161000785799	F													14/9/10	RH	Trap	468
321	985161000785859	F									16/9/09	DTCH	Trap	581	29/8/10	DTCH	Trap	570
322	985161000785867	M													2/9/10	HDDN	Trap	399
323	985161000785873	U													14/9/10	HDDN	Trap	578
324	985161000785894	M													17/9/10	HDDN	Trap	524
325	985161000785923	U													14/9/10	HDDN	Trap	507
326	985161000785937	U	9/8/07	OLDM	E-fish	310												
327	985161000786034	U					13/9/08	HDDN	Trap	500								
328	985161000786060	U	1/8/07	GAP	Angle	460												
329	985161000786069	U					30/9/08	LVGS	Trap	517								
330	985161000786090	U									10/9/09	HDDN	Trap	424				

Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
331	985161000786217	U									21/9/09	RH	Trap	624				
332	985161000786253	U													20/9/10	HDDN	Trap	426
333	985161000786303	U	30/8/07	HDDN	Trap	650												
334	985161000786317	U	19/7/07	GAP	Angle	535												
335	985161000786360	M													10/9/10	HDDN	Trap	429
336	985161000789086	U	21/8/07	RH	E-fish	409												
337	985161000790310	U	11/7/07	OLDM	E-fish	563												
338	985161000822235	U													15/9/10	RH	Trap	558
339	985161000822473	U	16/9/07	HDDN	Trap	650												
340	985161000823837	U					11/9/08	RH	Trap	475								
341	985161000823891	U					3/10/08	RH	Trap	496								
342	985161000824256	U	8/9/07	HDDN	Trap	540												
343	985161000824441	U	19/7/07	GAP	Angle	558												
344	985161000826063	U					8/10/08	LVGS	Trap	558								
345	985161000826518	F	6/9/07	HDDN	Trap	546									11/9/10	HDDN	Trap	554

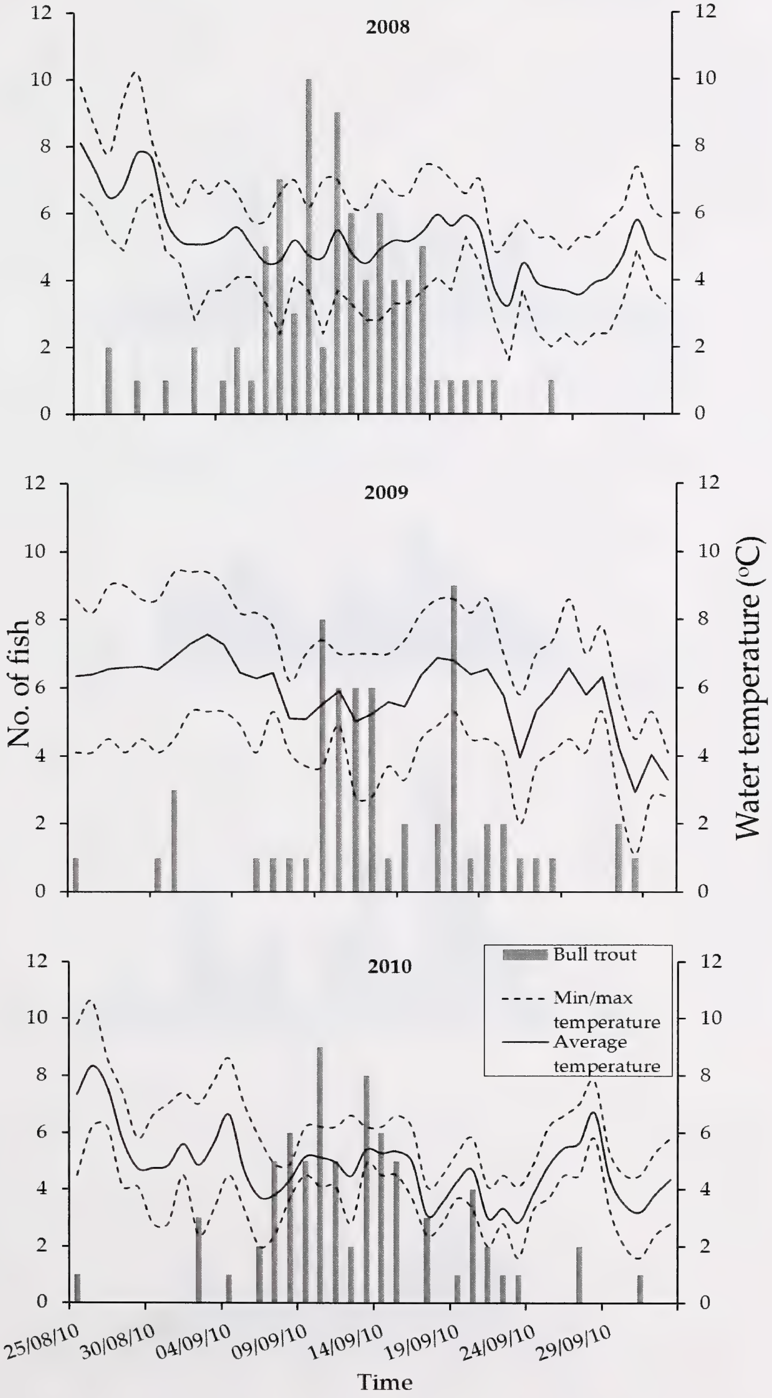
Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
346	985161000827173	U	25/9/07	LVGS	E-fish	562												
347	985161000836228	U									14/6/09	WALD	Angle	446				
348	985161000836920	F	2/9/07	HDDN	Trap	493					6/9/09	HDDN	Trap	521	9/9/10 15/9/10	HDDN LVGS	Trap Trap	543 543
349	985161000838318	U	19/7/07	RH	E-fish	725												
350	985161000838430	U	28/8/07	HDDN	Trap	672	27/9/08	RH	Trap	683								
351	985161000838443	M					15/9/08	HDDN	Trap	660					14/9/10	HDDN	Trap	677
352	985161000838554	U	25/9/07	HDDN	Trap	748	17/9/08	HDDN	Trap	751								
353	985161000839219	U					6/5/08	WALD	Angle	637								
354	985161000851935	M													14/9/10	DTCH	Trap	455
355	985161000852779	U					15/9/08	HDDN	Trap	542								
356	985161000854426	U													9/9/10	HDDN	Trap	461
357	985161000855442	U					8/9/08	HDDN	Trap	491								
358	985161000855813	U					10/9/08	HDDN	Trap	472								
359	985161000856052	U	4/8/07	HDDN	Trap	530	15/9/08	LVGS	Trap	534								
360	985161000857067	F					9/9/08	RH	Trap	621	7/9/09	RH	Trap	636	7/9/10	RH	Trap	640

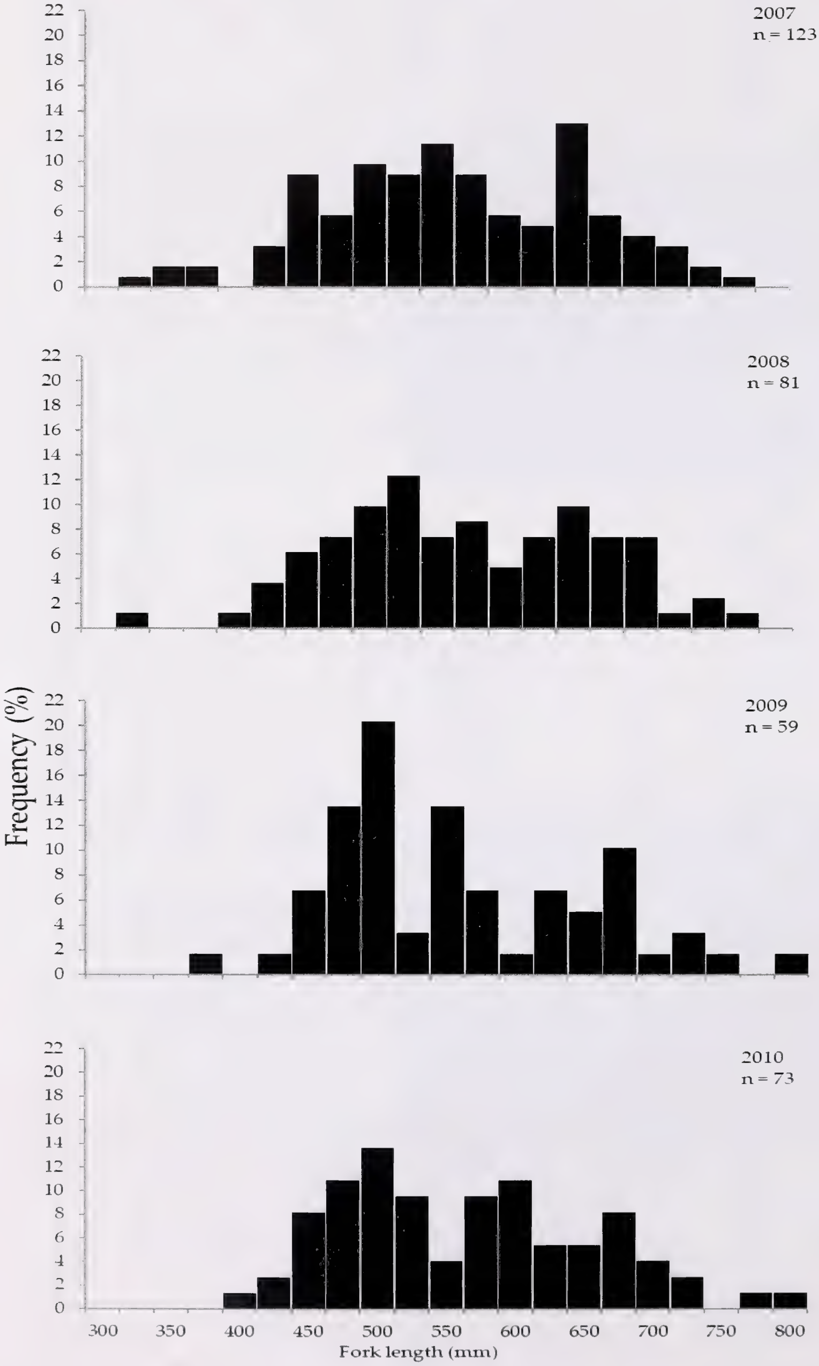
Appendix 3. Continued.

			2007				2008				2009				2010			
No.	PIT Tag #	Sex	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)	Date	Waterbody	Capture	FL (mm)
361	985161000942592 985161000942592	U					10/9/08 19/9/08	RH LVGS	Trap Trap	597 595	10/9/09	RH	Trap	602				
362	985161000943514	U									10/9/09	HDDN	Trap	485				
363	985161000947201	U	3/8/07	HDDN	Trap	372	13/9/08	HDDN	Trap	393								
	Mortalities																	
364	985161000XXXXX1	U	1/8/07	HDDN	Trap	635												
365	985161000XXXXX2	U	28/8/07	HDDN	Trap	350												
367	985161000XXXXX3	U					5/9/08	DTCH	Trap	614								
368	985161000XXXXX4	U													20/9/10	HDDN	Trap	-

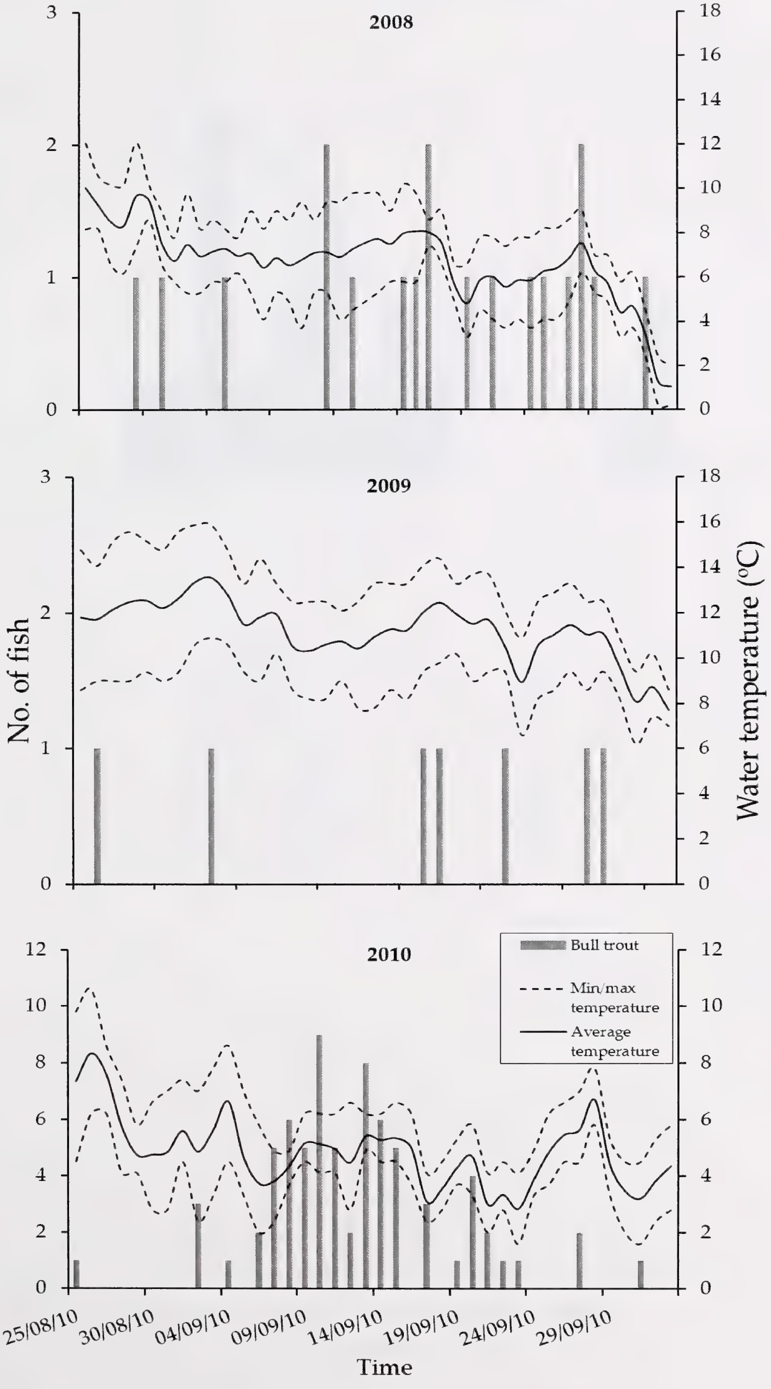
Appendix 4. Timing of the post-spawn migration of bull trout and daily average water tempertures in Hidden Creek, 2008 – 2010.



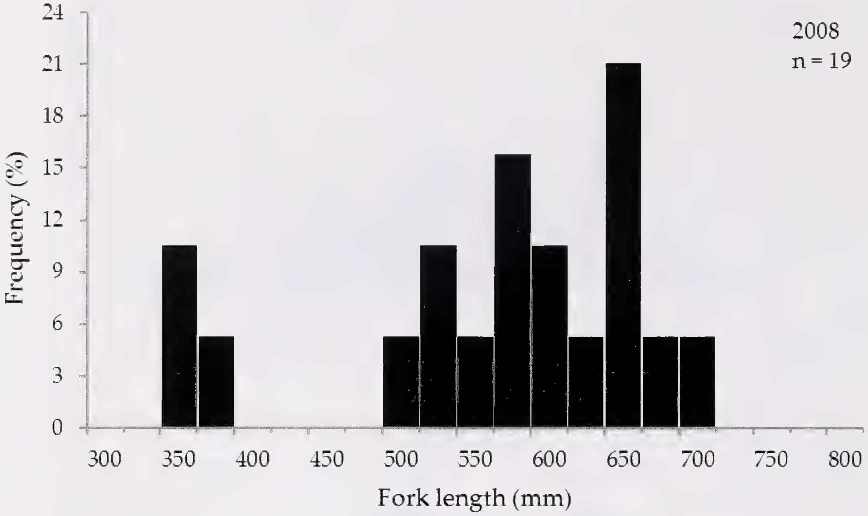
Appendix 5. Length-frequency distribution of bull trout captured in Hidden Creek, 2007 – 2010.



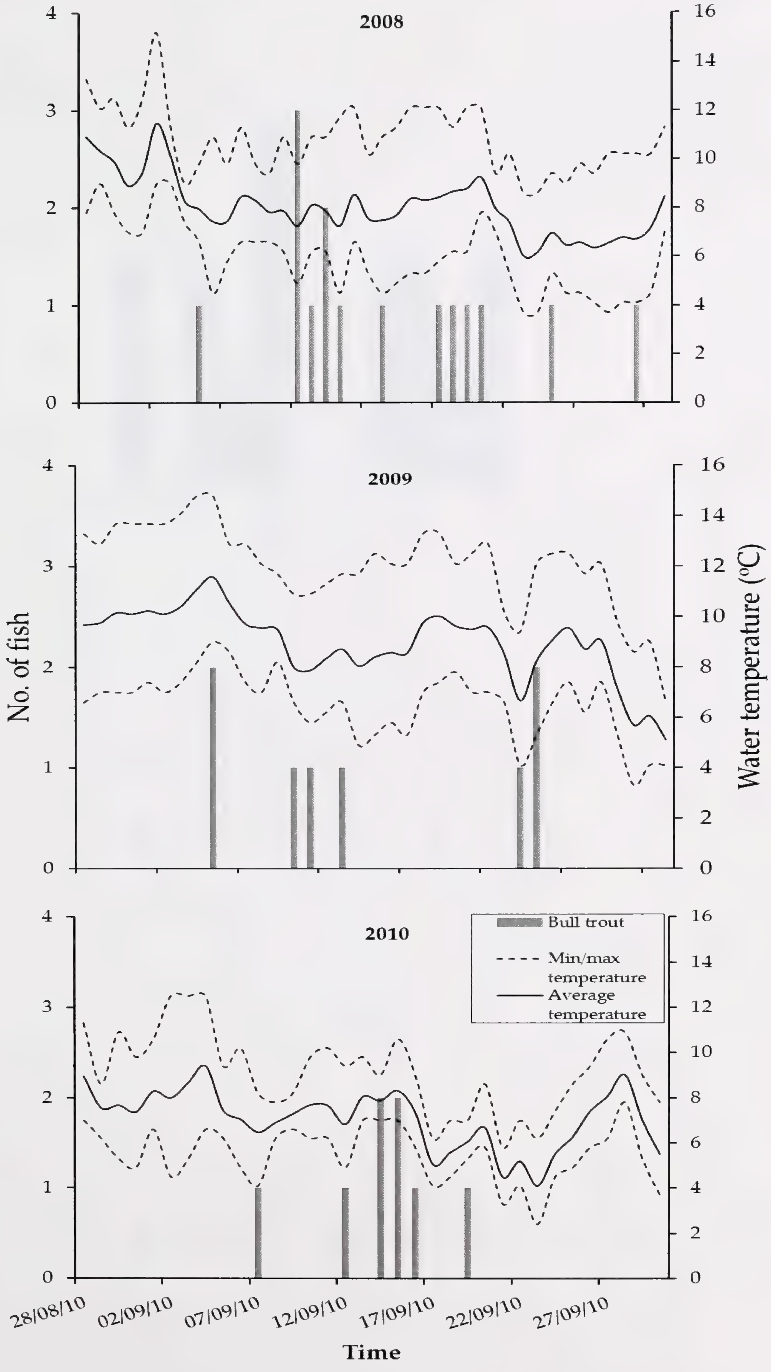
Appendix 6. Timing of the post-spawn migration of bull trout and daily average water tempertures in the lower Livingstone River, 2008 – 2010.



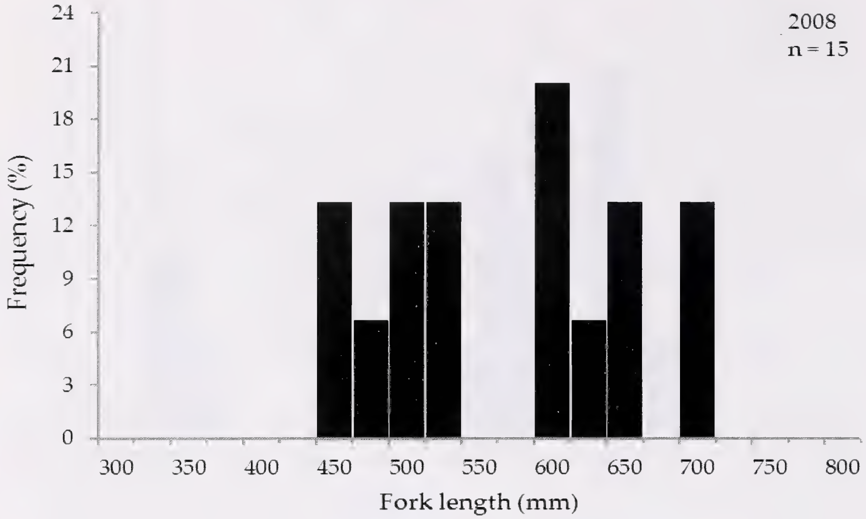
Appendix 7. Length-frequency distribution of bull trout captured in the lower Livingstone River, 2008.



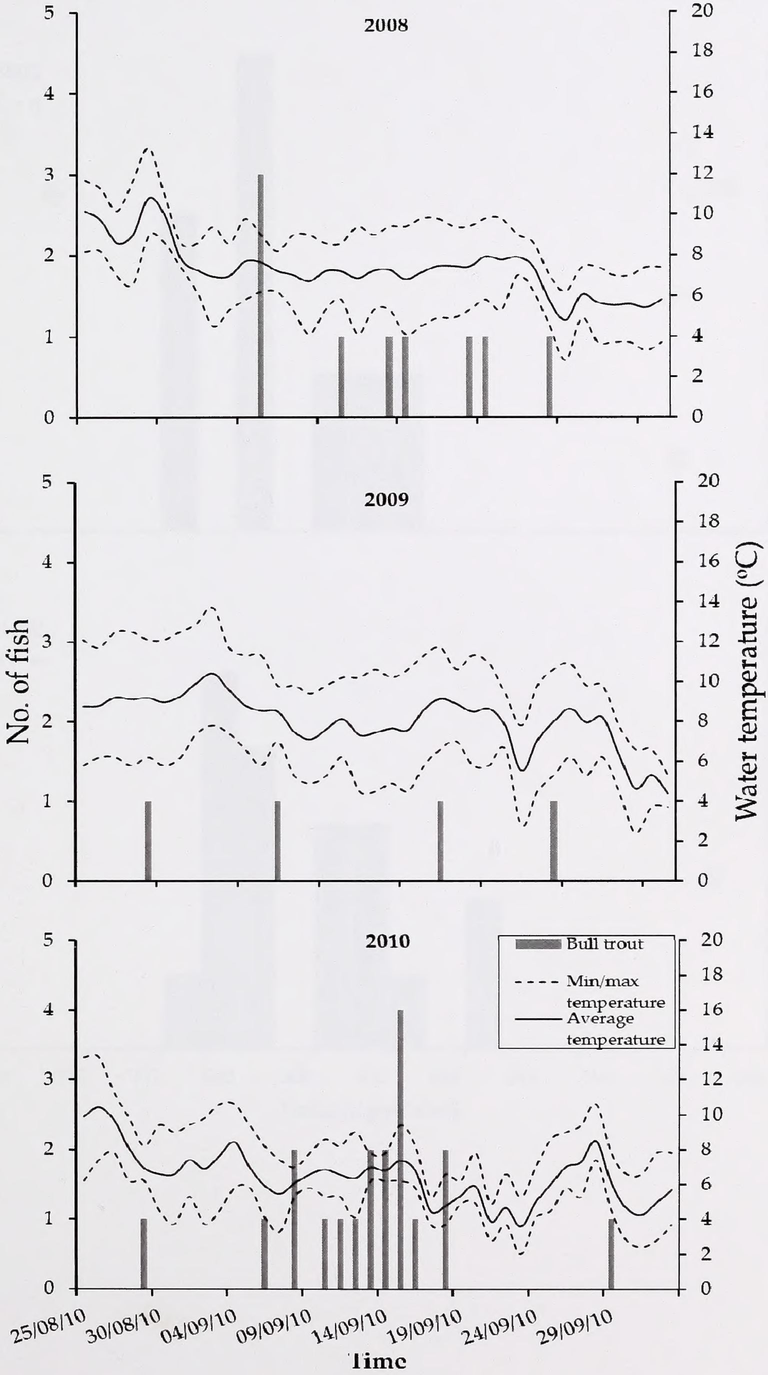
Appendix 8. Timing of the post-spawn migration of bull trout and daily average water tempertures in Racehorse Creek, 2008 – 2010.



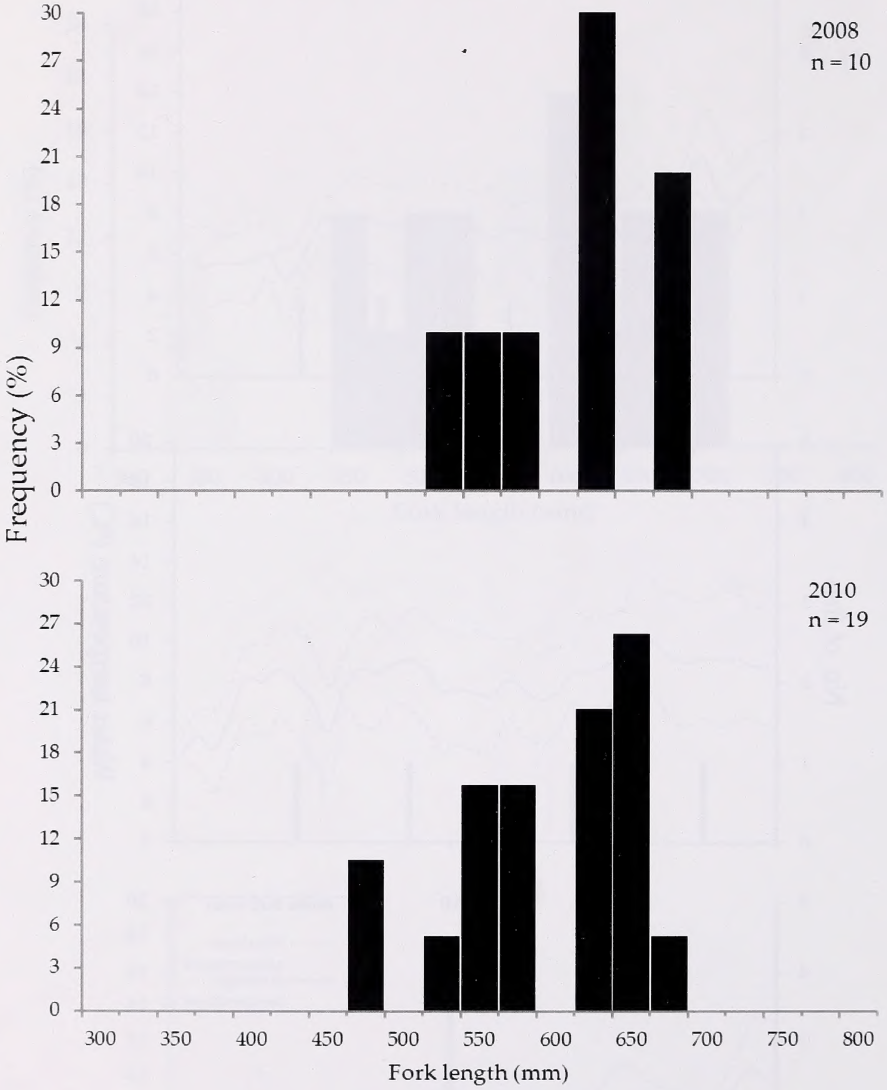
Appendix 9. Length-frequency distribution of bull trout captured in Racehorse Creek, 2008.



Appendix 10. Timing of the post-spawn migration of bull trout and daily average water tempertures in Dutch Creek, 2008 – 2010.



Appendix 11. Length-frequency distribution of bull trout captured in Dutch Creek, 2008 and 2010.



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The Alberta Conservation Association acknowledges the following partners for their generous support of this project

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